THURSDAY, SEPTEMBER 16, 1915.

AGRICULTURAL TEACHING IN AMERICAN SCHOOLS.

The Essentials of Agriculture. By H. J. Waters. Pp. x+455+xxxvi. (Boston and London: Ginn and Co., 1915.) Price 1.25 dollars.

PRESIDENT WATERS tells us in his preface that the American people have decided that the public schools shall teach pupils "to think and to do," and shall give a training intimately related to the life the student expects to lead. As a necessary consequence agriculture figures largely in American schools, and we are told that wherever it is well taught it has proved to be a source of strength—whether the institution is a one-teacher country school, a high school, a college, or a university. The most successful method is to make the teaching local, taking the whole neighbourhood as the laboratory, and drawing abundantly on the local farms, gardens, orchards, and lanes, and the recognised local experts for the apparatus and materials required.

The teacher who embarks on such a course soon runs up against considerable difficulties, because none of the simple cases described in the popular book ever seem to occur in his own district; and, on the other hand, the problems in his district appear to be tantalisingly ignored by the book. It is indispensable, therefore, that the teacher's library shall contain only books by men of wide experience, and for this reason a special welcome is sure to be given to President Waters's book, for few men can claim to possess the necessary qualifications in greater degree.

The opening chapters set out briefly the principles on which the "new agriculture" rests. Under American conditions, where one or two men with modern machinery work a large farm, the man-yield is high though the acre-yield is low. Under European—including British—conditions the acre-yield is high, but the man-yield is low. What is wanted is a combination of the two. President Waters, therefore, proceeds to set out the conditions necessary for an increase in the acre-yield.

First of all, better plants and animals are needed. An account is given of the way in which improvements have already been effected in the common crops and live-stock, and the underlying principles are clearly set out. The author next discusses how plants feed and grow, and deals not only with plant food in the conventional sense but also with the water relationships of the crop, a subject to which American investigators have rightly paid considerable attention. This is followed by a section on soils, and emphasis is laid at the outset on the need for adopting a conservative policy. "We may be wasteful and careless of everything else," says the author, quoting William Brown, "but the land belongs to the Ages. We are trustees holding this land . . . and the happiness, the comfort, and the very existence of our children's children, and the millions who will follow, is dependent upon the conscientious, far-seeing wisdom with which we discharge this solemn trust." This high line is adopted by many of the most distinguished teachers of the United States, and is the key-note of much of the development work of recent years. The author follows Cyril Hopkins in working out his illustrations, and gives actual figures to show what quantities of nitrogen, phosphorus, potassium, etc., must be present in the soil in order to give a full crop. In Dr. Hopkins's experience the method works satisfactorily, although it has been the subject of much criticism. The quantities of these materials present in any ordinary soil are far in excess of the requirements of the crop, and it is necessary to assume that they are mostly in combinations unavailable for the plant, but that they become available at a certain rate per annum: 2 per cent. of the nitrogen, 1 per cent. of the phosphorus, and 0·25 per cent. of the potassium, being the rates quoted here. Naturally, a comparison can only be set up between soils of similar types under similar climatic conditions, but the actual procedure is much like the one that answers very well in this country, although based on a different principle.

The author next passes on to manures, and has much to say about the losses and wastage to which farm-yard manure is often subject. It is estimated that the amount produced in the United States each year is worth more than two billions of dollars, *i.e.*, more than the entire wheat or corn crop, and that nearly one-half is wasted. We ourselves are in no better case; the illustrations given by the author could be paralleled in this country. Fortunately the matter is being seriously taken in hand at Rothamsted and other experimental stations.

Individual crops and animals are then described, and the book closes with chapters on the business aspects of farming, and on mechanical power for farmers.

The book brings home vividly to the reader the enormous part played by the experiment stations in the development of American agriculture. The advances made during the last forty years would appear incredible if they were not accomplished

facts, and the book is so well written and so well illustrated that the student must see at once that the hope for the future lies in the close co-operation of farmers and experiment station investigators. Both in matter and in spirit it is entirely commendable. E. J. RUSSELL.

MOLLUSCS, MAMMALS, AND MEMORABILIA.

(1) *Our British Snails.* By the Rev. Canon J. W. Horsley. Pp. 69. (London: S.P.C.K., 1915.) Price 1*s.* net.

(2) *Land and Freshwater Mollusca of India, including South Arabia, Baluchistan, Afghanistan, Kashmir, Nepal, Burmah, Pegu, Tenasserim, Malay Peninsula, Ceylon, and other Islands of the Indian Ocean.* Supplementary to Messrs. Theobald and Hanley's Conchologia Indica. By Lieut.-Col. H. H. Godwin-Austen. Vol. ii. Part xii. December, 1914. Text. Pp. 311–442. Vol. ii. Part xii. December, 1914. Plates cxxxiii–clviii. (London: Taylor and Francis, 1914.) Price 25*s.*

(3) *Catalogue of the Ungulate Mammals in the British Museum (Natural History).* Vol. iv. Artiodactyla, Families Cervidæ (Deer), Tragulidæ (Chevrotains), Camelidæ (Camels and Llamas), Suidæ (Pigs and Peccaries), and Hippopotamidæ (Hippopotamuses). By R. Lydekker. Pp. xxi+438. (London: British Museum (Natural History), and Longmans, Green and Co., 1915.) Price 10*s.* 6*d.*

(4) *Nature and Science on the Pacific Coast. A Guide-book for Scientific Travellers in the West.* Edited under the auspices of the Pacific Coast Committee of the American Association for the Advancement of Science. Pp. xii+302+plates. (San Francisco: Paul Elder and Co., 1915.) Price 1.50 dollars.

(1) CANON HORSLEY'S clever little manual encourages food-thrift by pointing out that "all snails are edible and nutritious," even the garden snail being indeed "insipid; but as nourishing as calf's-foot jelly." Under the general heading of British snails it includes the slimy slug with scanty shell, and the aquatic bivalved pearl-bearing Unio. The statement that "there are but eighty-two land and forty-five freshwater shells in Britain" is slightly modified by the subsequent discrimination of forty-nine British freshwater species, including *Neritina fluviatilis*, for which, as recently shown, the generic name should preferably be de Montfort's Theodoxus. A gentle warning against the extirpation of rare species might have been added, to qualify the impulse to the study of natural history in general given by such remarks as the following: "If you want to make a collection, whether of dried plants, of insects, of shells, or of anything else, you must cultivate ways of order and method and neatness in the arrangement of your collection; and then your increased powers of observation, of comparison, and of method" will, the author believes, augment in you the virtues of prudence, justice, temperance, and fortitude.

(2) If you want to make a collection of books, and to cultivate order and neatness in the arrangement, what sort of temperate language will you apply to persons who publish the text of an important work in octavo and the plates in quarto? This is the afflicting arrangement in the otherwise admirable treatise on the land and freshwater mollusca of India. Doubtless the distinguished surveyor and veteran naturalist is responsible for the matter, not the form, of his book.

The book opens with a discussion of the Limacidæ, and a statement that "representatives of this family have not hitherto been described from the Himalayan range." But the bulk of this part xii. is concerned with a most industrious survey of the genus Alycæus, continued from Part vii., published in 1897. Here Col. Godwin-Austen notes that his outline of the sub-family Alycæinæ (vol. i., part v.) in 1886 now requires amplification because in the intervening twenty-eight years the number of known species has very greatly increased. That the members of the genus are not usually of gigantic size may be inferred from *Alycæus* (*Raptomphalus*) *magnificus* n. sp., since this magnificent and "very beautiful" species is less than a fifth of an inch, 4·25 mm., in its major diameter. Through quotation of original descriptions, intended to be exact, measurements are variously referred to mm., mill., in., unc., sometimes with rather confusing results. Thus *Alycæus cucullatus*, Theobald, is credited with a "Diam. maj. 21, diam. min. 20; alt. 21 unc.," and the notice that "This is a remarkably fine species." It certainly must be if it has a breadth of 21 inches and an equal height, but the figure magnified "×8," measures only 1⅝ in. across, with a height less than an inch. Even by a sprinkling of decimal points the dimensions cannot be harmonised with the illustration. Among matters of general interest, as apart from technical descriptions, special reference may be made to the discussion of *Alycæus* (*Cycloryx*) *graphicus*, illustrative of variation in shell-character in connection with distribution.

(3) By its title "Mollusca to Man," a well-known volume long ago hinted at a lowly lineage for humanity itself. This notice may therefore be excused for passing abruptly from slugs and snails to the graceful deer and ponderous hippo-

potamus with which the Museum catalogue of Ungulate Mammals is concerned in its fourth volume. This work closes the scientific career of Richard Lydekker. Its accuracy is guaranteed by the trusty supervision of Oldfield Thomas. The facile unwearying pen of its actual author writes no more. A preface by Dr. Harmer commemorates Lydekker's devotion to work, and the esteem in which he was held by his colleagues.

The volume has one feature challenging at least a note of admiration. It abounds in such names as *Moschus moschiferus moschiferus, Odocoileus virginianus peruvianus, Hylochœrus meinertzhageni meinertzhageni*! Surely "when ghost meets ghost" in the Elysian fields Linnæus will pertinently ask the newcomer, "Who is responsible for this violence to the serene simplicity of my binomial nomenclature?"

(4) "Nature and Science on the Pacific Coast," by thirty highly qualified writers, is a handbook of which it is not too much to say that quotations could agreeably and instructively fill many columns. Within a limit of fewer than 300 pages for the whole, each author has had to condense his wealth of information into the smallest possible compass. From the theory of earthquakes and the origin of petroleum to the war between benevolent bugs and pestilent scale-insects, from the history of the Panama Canal to the "influence of natural conditions upon legal and political institutions," nothing seems to have been forgotten. Geology and astronomy, flora and fauna, industries and amusements, have each their turn, with indices to literature for information beyond what can be compressed into a nutshell. Fishes receive more notice than mammals, and an extract from their record may be usefuily quoted.

"Besides the trout and salmon, California has many other game fishes. First of these is the great tunny or leaping tuna, which ranges from 150 pounds to half a ton, and finds its greatest abundance about Avalon. This wonderful bay of Avalon has many other roving fishes, taken with the trolling spoon, such as the yellow-tail (*Seriola dorsalis*), the albacore (*Thunnus alalunga*), the yellow-fin, or Japanese albacore (*Thunnus macropterus*), and the huge bass called Jew-fish (*Stereolepis gigas*), with a head as large as a bushel basket—apparently nearly all head. The sword-fish (*Xiphias gladius*), and the Japanese spear-fish (*Tetrapturus mitsukurii*), are also sometimes taken off the Santa Barbara Islands.

"These noble fishes deserve protection from the amateur angler who catches a dozen or a hundred, has them hung up and photographed, himself beside them, then hires the guide to bury them while he goes away to have fun in his own fashion somewhere else."

THOMAS R. R. STEBBING.

AN ITALIAN TEXT-BOOK OF PHYSIOLOGY.

Human Physiology. By Prof. L. Luciani. Translated by F. A. Welby. Vol. iii.—Muscular and Nervous Systems. Edited by Dr. G. M. Holmes. Pp. x+667. (London: Macmillan and Co., Ltd., 1915.) Price 18*s*. net.

THE third volume of the English version of Luciani's "Human Physiology," translated from the Italian original published in 1913, deals with the general physiology of muscle, the mechanics of locomotion, phonation, and articulation, and the general and special physiology of the nervous system.

The chief characteristics of Luciani's work have already been referred to in the reviews of the first two volumes. The first chapter of the present volume gives an excellent account of the general physiology of muscle. The successive stages in the historical development of the subject are described with great clearness and unusual fullness. Although an admirable account is also given of the most recent work, further details regarding the physico-chemical theories of muscular activity might possibly have been included with advantage. Fortunately the bibliography given at the close of the chapter offers excellent guidance to students desiring fuller knowledge of the latter views. In the discussion of the nature of voluntary muscular contraction, no reference is made to the important results obtained by Piper and others with the aid of the string galvanometer. The use of the latter instrument has enabled these observers to analyse the discontinuous character of voluntary muscular contraction more accurately than was possible by means of earlier methods.

A very full and clear account of the mechanics of the locomotor apparatus is given in chapter ii. The subjects of phonation and articulation are discussed much more thoroughly in chapter iii. than in most English text-boks of physiology, and the editor has found some abridgment desirable in the interests of students.

An exceedingly interesting summary of the most recent work on the metabolism of the nervous system is given at the close of chapter iv. The remainder of the volume is devoted to the special physiology of the central nervous system, and of the sympathetic system. A brief review cannot do justice to the clearness and completeness of the presentation given by the author. The very full account of the physiology of the cerebellum has a special value as the work of one of the greatest authorities in this field.

The English rendering given by Miss Welby

shows the high qualities of lucidity and excellent literary style characteristic of her previous work. The value of the text-book for English students has been greatly enhanced by the additions to the bibliography, which have been made by the editor, Dr. Gordon Holmes. In conclusion it may be stated that the high level of excellence secured in the first two volumes has been well maintained, and leaves no doubt that the work, when completed, will be a most important and valuable addition to the English literature of physiology.

ELEMENTARY GEOGRAPHY.

(1) *A First Geography of the British Isles.* By W. M. Carey. Pp. vi+169. (London: Macmillan and Co., Ltd., 1915.) Price 1*s.* 6*d.*

(2) *Bacon's Sixpenny Contour Atlas.* North England Edition. Pp. 41. Southern Wales Edition. Pp. 41. Lancashire and Yorkshire Edition. Pp. 41. (London: G. W. Bacon and Co., Ltd., n.d.) Price 6*d.* net each.

(1) THIS book has been written for classes preparing for preliminary or junior local examinations of the universities; it begins by considering latitude and longitude, and the climate of Britain is not considered until the last chapter; all this means that a good deal of previous reading and learning is presupposed. There is a large amount of information, much of it interesting and "curious," and it is markedly accurate; but the comparison of particulars and progression in idea which might be expected in a volume of a "First Book of Science" series are largely absent.

Of the eleven chapters which the book contains, eight deal with the geography of as many different regions, while the two first and the last deal with Britain as a whole. An excellent feature is that each chapter is preceded by about half a dozen practical exercises, and is followed by a similar number of questions partly taken from public examinations and partly original. The practical exercises probably supply the reason why the book is included in the series; but it may be doubted whether there are not too many of the type in which the lengths of certain rivers are given in miles and the pupil is asked to draw lines to represent those lengths to scale. As a means of keeping the youngsters quiet this is good, but the geographical value of the work is small, and it does not help them to remember the relative lengths. Notwithstanding its excellent qualities, we are disappointed with the book. The impression is that there are very many facts, but important and unimportant alike appear to receive the same attention.

The index would have been more useful had it been complete; on a page taken at random nine names were indexed and a dozen were not.

With (2) on the market in its several editions, no school, however straitened, can plead that it cannot afford a satisfactory atlas because of the cost. There are few other atlases on the market which at the price are possible rivals. Each edition contains four local maps, showing communications, geology, relief and vegetation, twenty-four regional relief maps, and seven world maps. It is a pity that some of the work is rather rough; in the Lancashire and Yorkshire edition the Aire Gap is shown on one map to be all under five hundred feet, on another map a small part is shown just over five hundred feet, while in a third the greater portion is shown as more than five hundred feet.

OUR BOOKSHELF.

Citrus Fruits. By Prof. J. E. Coit. Pp. xx+520. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

THIS work is written by the professor of citriculture of the University of California, where he is also superintendent of the University Agricultural Experiment Station with regard to citrus fruits. The first chapter deals with the history and development of the citrus industry in California from the introduction of European fruit trees and vines by Spanish Jesuit missionaries about 1701, and traces the industry to the present time, recording the assistance to its upbuilding rendered by the Department of Agriculture, the University of California, and the Chambers of Commerce, which have aided by lectures, experiments, and advertisement, leading up to the practical result, namely, the shipment of 60,000 carloads of fruit in 1914.

The following chapters deal with the geography and climate of California; the botany of citrus fruits, their varieties and origins; improvement of varieties by breeding, and from "sports"; judging fruits; site and preparation for planting; cultivation, manuring, cover crops; irrigation; pruning and top-working; frost and orchard heating; picking and packing; blemishes and their prevention; manufacture of by-products (citric acid, candied fruit, etc.); marketing; cost and returns; diseases and their control; insect control and fumigation; horticultural inspection and quarantine; legislation.

Budding, even of old trees, is found more successful than grafting. Some of the best varieties of orange (Navel) and lemon (Eureka) are parthenocarpic, and can successfully be planted in large blocks, but most varieties require cross-pollination, and some varieties are found not to be congenial pollenisers.

The author considers the selection of "sports" a more likely source of valuable varieties than by hybridising and raising new sorts.

The above are a few selected facts of interest, but the book will be found interesting even in a country where the orange is not commercially grown, and invaluable where citrus fruits are a staple industry. CECIL H. HOOPER.

Lessons in Elementary Physiology. By Dr. T. H. Huxley. Enlarged and revised edition. Pp. xxiv + 604. (London: Macmillan and Co., Ltd., 1915.) Price 4*s.* 6*d.*

PROF. HUXLEY'S "Physiology" was a masterpiece; it first appeared in 1866, and since that date has been easily first among a crowd of elementary manuals. The edition which appeared before the present one was issued in 1900, and was then edited by Sir Michael Foster and Dr. Shore. It has been frequently reprinted since that date, but after a lapse of fifteen years the publishers have very rightly judged that it required revision in order to incorporate the new facts and generalisations which have been discovered in the meantime. This work has been entrusted to Mr. Joseph Barcroft, of Cambridge, and he has fulfilled his task with ability, tact, and, one may add, reverence. Although the repair has been substantial, one cannot but be struck with the fact how much of the fabric is left intact. There could be no better testimony to the thoroughness and permanence of the labours of the original builders. The main principles of physiological science remain for the most part unchanged. With some notable exceptions, recent physiological progress has been concerned with details, which are interesting enough to the researchers, but are really not essential from the elementary student's point of view. We wish the present edition every success and a continuance of usefulness. W. D. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Remarkable Nest of "Vespa norwegica," and Fertility of Workers of this Species.

THE following observations on a colony of *Vespa norwegica* are perhaps deserving of record. About the middle of July a relative living at East Liss, Hants, endeavoured to take for me a nest of this tree-wasp, but was forced to beat a retreat after merely bending the branch of the rhododendron to which the nest was attached. The effect of this bend was to throw the nest permanently out of its original position, and to incline the combs within it at a considerable angle to the horizontal plane in which they had, as always, been built. On July 28 the nest was successfully captured, and forwarded to me, together with such of its inmates as happened to be at home at the moment of capture. The combs were five in number; the three upper were each of about four inches in diameter; the fourth smaller and of irregular shape, there being a patch of small, misshapen cells placed obliquely on one margin. The position of the fifth comb was very remarkable; it was attached, not to the fourth, but to the third comb; and, moreover, instead of hanging parallel to the other combs, it was set at a decided angle to them, the angle being such that it lay in the true horizontal plane, from which the others had been displaced. It is thus evident that the worker wasps are able to discriminate between oblique and horizontal positions with some nicety. This fifth comb had obviously been built since the disturbance of the nest; it consisted of but twenty-five small, though regularly hexagonal cells, and it is probable that the patch of irregular cells added to the edge of the fourth comb was of similar date, and represents an attempt to regain the horizontal plane for that comb. The queen had also been affected by the disturbance of the nest, for she had laid two, and frequently three, eggs in many of the cells of the second and third combs, instead of the normal one egg only. There were no eggs in any of the cells of the oddly-placed fifth comb, nor in the patch of irregular cells on the edge of the fourth. The absence of eggs from these cells points to all workers being sterile up to the time when the nest was taken. Within the nest as I received it were several dozen drones, two workers, and the queen; the majority of the workers must have been afield when the nest was removed.

On August 24 I visited the bush whence the nest was obtained, and found that the workers had continued operations, although bereft of their queen. On the ground immediately beneath the place of the original nest they had built an irregular mass of wasp-paper round some dead twigs of heather, and in the midst of this mass, smothered in the wasp-paper wrappings, was a very small comb consisting of six badly-shaped cells, of which two contained eggs that had failed to develop and had shrivelled. But fastened to a branch about a foot above this mass was a small nest of normal shape, and of about two and a half inches diameter, such as might be expected in early summer. Worker wasps were visiting both these structures, and occasionally one would emerge from the nest and proceed direct to the mass upon the ground, or *vice versâ*; both were clearly the work of the one colony. I caught all the wasps—only thirty-seven in number—and found them to be workers without exception. Inside the suspended nest was one small, but perfectly regular comb composed of forty-four cells, thirty-three of which contained larvæ of various sizes. None of these larvæ looked healthy or well nourished, and three of the largest were dead and had turned pink. There was no queen in the nest; hence it is certain that at least one of the workers must have become parthenogenetically fertile.

It is probably not unusual for workers to become fertile in strong colonies towards the end of a favourable season; but I am not aware that such clear proof of worker fertility has hitherto been obtained, and it is certainly singular that reproductive powers should arise in the circumstances above narrated.

OSWALD H. LATTER.

Charterhouse, Godalming, September 7.

An Original Representation of the Giraffe.

AMONG the interesting reproductions of early figures that Prof. Eastman has lately presented to the readers of NATURE are two of the giraffe—one (NATURE, February 18) from Ehrenberg's memoir published in 1834, and the other (July 29) from a manuscript in the British Museum. Both these figures are attributed to Thebes; the former, from a "monument," is shown with a monkey-like animal on the back of its neck, and the latter, from a "tomb," has the monkey in

front of the neck. In both cases the giraffe faces towards the right, and there can be little doubt that they are efforts of our recent ancestors to try to copy an ancient picture.

G. A. Hoskins published his "Travels in Ethiopia" in 1835; consequently his animal figures are entitled to rank as early representations, though they were not done with zoological intent. A feature of the work is a series of colour-printed plates showing an expedition returning from the land of Punt, and among the figures appears to be the original of Prof. Eastman's giraffes. The accompanying illustration (Fig. 1), due to the skilled hand of Mr. W. Ashton, serves to show the delicate accuracy of Hoskins's copy, which must in its turn be very closely similar to the Egyptian painting. Attention may be directed to the prehensile lips, the form of the shoulders, and the tuft of hair at the end of the tail. The colouring of Hoskins's plate enhances the accuracy of the details. The giraffe is only an item, and, like the elephant in the same procession, is evidently a young animal, as it is only a little taller than the men in charge of it. The painting includes the leopard, hunting cat, ibex, dogs, cattle, and a curious bear-like animal, the portrait of which is probably as true to life as the others. Four distinct races are shown among the human figures who are carrying elephants' tusks, ostrich feathers and eggs, and skins of different kinds, as well as many other treasures from the southern lands.

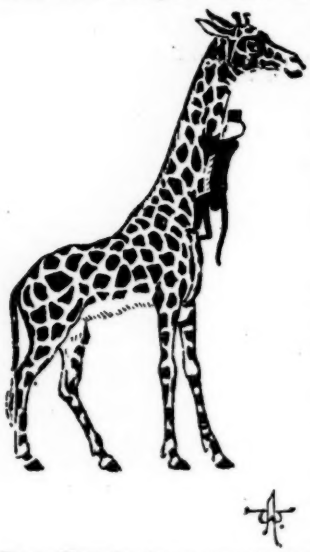

FIG. 1.—Illustration of giraffe. From Hoskins's "Travels in Ethiopia."

Hoskins states that the original painting was in a tomb of the time of Thothmes III., but excavation had not then proceeded far, and possibly the structure is what we now know to be the west terrace of Queen Hatshepset's temple of Der el Barhari. Here, according to Dr. E. A. Wallis Budge's description, there are bas-reliefs that must be very similar to, if not identical with, the painting copied by Hoskins. The expedition to Punt was a feature of Queen Hatshepset's reign, and occurred about 1600 B.C., while the association of Thothmes's name is accounted for by this gentleman's habit of substituting it for that of his predecessor.

G. W. GRABHAM.

Khartoum, August 21.

THE WORLD'S SUPPLY OF POTASH.

IN view of the scarcity of potash occasioned by the war, the Imperial Institute has issued a pamphlet (pp. 47, price 1*s.*) under the above title, in which a review is given of the existing sources of supply and suggestions made as to the possibility of obtaining potash from materials not hitherto worked for this purpose. The potash used in this country has been almost exclusively derived from the Stassfurt deposits, south of Magdeburg, which have been so systematically and economically worked since about 1862, that German potash, on account of its cheapness, has driven all other competitors from the market. Potash salts are essential constituents of plant food, and the greater part of the potash salts extracted at Stassfurt is used as a fertiliser; but relatively large quantities are employed in various chemical industries and in the manufacture of glass and soap.

Besides the Stassfurt deposits, there is only one extensive deposit of carnallite at present known, and that is the Spanish deposit of Catalonia, the working of which, it is stated, has recently been commenced. This deposit has great commercial promise, and, next to those of Stassfurt, may prove to be the most important source of potash at present known. There are also deposits in India, which may prove to be of importance if they can be worked sufficiently cheaply.

All plants contain more or less potash, and the utilisation of the ash of wood, the ash of seaweeds, of beetroot residues, and similar by-products of industries in which vegetable raw materials are employed, is of importance as a source of potash, especially at a time of scarcity like the present. The burning of seaweed and the extracting of potash from the ash, at one time an important industry on the coasts of Scotland and Ireland, has recently shown signs of revival. From Ireland during 1913, 3939 tons of kelp, valued at 16,631*l.*, were exported. As a rule the Irish kelp contains more potash than that produced in Scotland. At the present time the utilisation of the giant kelps of the Pacific coast is regarded by many as the most promising source of soluble potash salts in the United States. The best account of the new industry which has sprung up on the Pacific shores was given by F. K. Cameron in a paper read before the Franklin Institute in 1913 (Journ. Franklin Institute, vol. clxxvi., p. 347). According to an official estimate 6,000,000 tons of potassium chloride could be obtained annually from this source. It was shown by Balch in 1909 that the giant algæ of the Pacific, the principal species being Nereocystis and Macrocystis, contain about five times as much potash as the majority of seaweeds, the average percentage on the dried weed being from 15 to 20 per cent. of K_2O. Since the publication of these results various labour-saving devices have been tried for cutting and collecting the weed, and the cost per ton of weed now landed is stated to be about 20 cents.

The preparation of potash salts and iodine has also become an important industry on certain parts of the coast of Japan, and it is stated that Japan now supplies about 80 per cent. of the iodine consumed in the United States. The weeds used on the coast of Japan are species of Laminaria, *Ecklonia cava, E. bicyclis,* and Sargassum, spp.

In Canada the burning of wood to ash was for several years a considerable source of potash, but

in a report recently issued by the Forestry Branch, Department of the Interior, it is stated that at the present day, owing to altered conditions, there is small possibility of reviving the potash industry as formerly practised. The amount of potash to be recovered from the waste from the sawmills is considered to be too small to be regarded as commercially practicable for the mills to undertake its recovery. In most cases the only use for the ash from sawmill burners is for the farmers in the locality to apply it directly on the land.

Experiments made at Rothamsted recently have shown that the ash of hedge cleanings, consisting of grass, weeds, and clippings, contained on the average about 11 per cent. of potash, that is to say, about as much as kainit (Russell, Journ. Board Agric., 1914, vol. xxi., p. 694). The potash is present in a very soluble form (carbonate) and is rapidly washed away. If it is to be utilised, therefore, care must be taken to protect the ashes from showers of rain while they are cooling.

A rather neglected source of potash is the soapy water used for removing grease from wool. The matter soluble in water contains potash equivalent to 5 per cent. of potassium carbonate, calculated on the raw wool, but as the recovery of potash is not remunerative unless conducted on a large scale, the wool washings are usually allowed to go to waste. On the other hand, in Belgium, France, and Germany the wool suint is utilised as a source of potash; it is estimated that in the Roubaix district alone potash salts to the value of 100,000*l.* are obtained annually from this source.

One of the most promising future sources of potash supplies seems to be the recently discovered deposits in Alsace. In 1904 deep borings were made at Niederbruck in the hope of striking oil, but instead saline matter was encountered at the depth of 1174 ft. Since then the number of mines has increased to twelve; in 1912 the output was 137,243 metric tons, and in 1913, 350,341 metric tons. Recent reports state that the Alsatian deposits are probably continued across the Rhine into Baden.

During the past few years attention has been directed to the possibility of employing as manures, with or without previous treatment, minerals which contain potash in an insoluble form; the more important of these are alunite, felspar, and leucite. An account is given in the pamphlet of the methods which have been experimented with. W. A. D.

PROF. D. T. GWYNNE-VAUGHAN.

AFTER completing barely one year of duty in the chair of botany at Reading, Prof. Gwynne-Vaughan died on September 4. He was only forty-four years of age, but he had made a solid position for himself as a plant anatomist, and he had already shown his capacity as a teacher and a director of research. A life not only of promise, but also of notable achievement has thus come to a premature close.

Born in 1871, at Llandovery, he was educated at Monmouth School, whence he passed as scholar to Christ's College, Cambridge, and took the Natural Sciences Tripos. After graduation he held a mastership for a time, but soon relinquished it to pursue research. For this end he went to the Jodrell Laboratory, Royal Gardens, Kew, which was then under the directorship of Dr. D. H. Scott. Here his investigations of stelar morphology began, and in 1897 he published his first results on Nymphæaceæ (Trans. Linn. Soc.) and Primulaceæ (*Annals of Botany*). A peculiarly lucid preliminary statement at the British Association at Liverpool (1896) led to his appointment as assistant in botany in the University of Glasgow, where he worked for about ten years, laying the foundation of his unrivalled knowledge of the anatomy of the Pteridophyta. In 1907 he became head of the department of botany in Birkbeck College, London, but after two years he was appointed professor of Botany in Belfast. Finally, in 1914, he took up similar duties at Reading. In 1911 he married Dr. H. C. I. Fraser, herself an accomplished botanist, who had succeeded him in the post at the Birkbeck College.

He acted for several years as secretary and afterwards as recorder of the botanical section of the British Association, winning the warm regard of all its members. His funeral occurring on the opening day of its current session in Manchester, the business of the section was by common consent suspended during the time of the service.

Gwynne-Vaughan's position as an anatomist is based, not only on his published works, but also upon a great accumulation of well-assured facts recorded in notes, which he readily made available to his colleagues. He was chiefly interested in stelar problems relating to the Filicales. From the list of his works two series of papers may be mentioned as of outstanding importance. The first includes the two memoirs on solenostelic ferns (*Ann. of Bot.*, 1901, 1903), in which he established the method of representation of the vascular system in the solid, as reconstructed from sections. The second series was written in happy co-operation with Dr. Robert Kidston, and dealt with the fossil Osmundaceæ (Trans. R.S. Edin., 1907–1911). Seldom have two minds blended their results more effectively. The one brought to bear a wide knowledge of fossils from the stratigraphical and systematic point of view. The other supplied critical and expert anatomical experience, based upon study of living plants. The result is a series of beautifully illustrated memoirs, which trace in a natural sequence of plants an anatomical progression which follows most convincingly the successive stratigraphical horizons. They also indicate the underlying method of that progression which finds its reflection in other series of vascular plants. Already these memoirs may be held to have taken their place among the botanical classics.

Work of such a nature already achieved makes

the more acute the loss of Gwynne-Vaughan at a relatively early age. To his colleagues he was most loyal and helpful. His own results were always strictly tested and criticised. The consequence will be that they will be durable, and take permanent place in the web of botanical science.

F. O. B.

THE BRITISH ASSOCIATION AT MANCHESTER.

THE British Association this year was favoured with exceptionally fine weather. The sun shone all day long, and not a drop of rain interfered with the visits to works and the short sectional excursions to places of scientific interest. The number of members and associates (1438), although satisfactory in the circumstances of a great European war, was small as compared with previous meetings. From these two factors it might have been anticipated that the attendances at the sections would be unsatisfactory. But from all accounts that have been received the section rooms have been well filled both in the morning and afternoon sittings, and the proceedings have been of quite exceptional interest and importance. It is evident, therefore, that the modifications of the usual programme that were made for the Manchester meeting have affected those who attend the association for the sake of the excursions and social functions far more than those who regard it seriously as an opportunity for scientific work and exchange of ideas.

It may be a question for the serious consideration of the council whether the Manchester model (1915), as it may be called, is not one which should be followed in future meetings of the association; but it may be said, without fear of contradiction, that the decision of the local executive committee to repeat its invitation, after the declaration of war, has been fully justified.

The reception by the Lord Mayor in the School of Technology on Wednesday evening was the only general social function of the week, but being fixed on the second day of the meeting it gave a welcome opportunity to members to meet their friends as well as to inspect the machinery, appliances, and lecture-rooms with which this great institution is equipped. The arrangements made by the committee for the visits of members to factories, warehouses, municipal undertakings, and various places of special interest in Manchester and district worked well, and the short excursions were well attended. The citizens' lectures given in Manchester and other towns in the neighbourhood attracted large audiences.

The meeting may be pronounced a decided success, and the vote of thanks to the local executive committee moved by the president at the concluding meeting on Friday evening was very heartily accorded.

Next year's meeting is to be held at Newcastle, under the presidency of Sir Arthur Evans, but final arrangements will not be made until about next March. The place of meeting in 1917 is to be Bournemouth.

Subjoined is a synopsis of grants of money appropriated for scientific purposes on behalf of the general committee at the Manchester meeting just concluded. The names of members entitled to call on the general treasurer for grants are prefixed to the respective committees. Reappointed committees are starred, and it will be noticed that of the forty-one committees receiving grants, only five are new.

	£	s.	d.
Section A—Mathematical and Physical Science.			
*Prof H. H. Turner—Seismological Observations	130	0	0
*Sir W. Ramsay—Tables of constants	40	0	0
*Prof. M. J. M. Hill—Mathematical tables	35	0	0
Section B—Chemistry.			
*Prof. H. E. Armstrong—Dynamic isomerism	20	0	0
*Prof. F. S. Kipping—Aromatic nitroamines	10	0	0
*Mr. A. D. Hall—Plant enzymes	10	0	0
*Prof. H. E. Armstrong—Solubility phenomena	5	0	0
*Prof. H. E. Armstrong—Eucalypts	30	0	0
*Prof. Orme Masson—Influence of weather conditions on nitrogen acids in rainfall and atmosphere	20	0	0
*Prof. W. J. Pope—Crystalline form and molecular structure	10	0	0
*Dr. F. D. Chattaway—Non-aromatic diazonium salts	8	10	0
Sir J. J. Dobbie—Absorption spectra, etc.	10	0	0
Section C—Geology.			
*Prof. Grenville Cole—Old Red Sandstone rocks of Kiltorcan	7	0	0
*Prof. W. W. Watts—Critical sections in Palæozoic rocks	20	0	0
*Prof. P. F. Kendall—List of characteristic fossils	10	0	0
Dr. J. Horne—Old Red Sandstone rocks at Rhynie	25	0	0
Dr. R. Kidston—Lower Carboniferous flora at Gullane	8	0	0
Section D—Zoology.			
*Dr. A. E. Shipley—Belmullet Whaling Station	25	0	0
Section E—Geography.			
*Sir C. P. Lucas—Conditions determining selection of sites and names for towns	15	0	0
Section F—Economic Science and Statistics.			
*Prof. J. H. Muirhead—Fatigue from economic standpoint	40	0	0
*Prof. W. R. Scott—Industrial unrest	20	0	0
*Prof. W. R. Scott—Women in industry	90	0	0
*Prof. W. R. Scott—Effects of war on credit, etc.	25	0	0
Section G—Engineering.			
*Prof. J. Perry—Complex stress distributions	40	0	0
*Dr. Dugald Clerk—Gaseous explosions	50	0	0
Dr. H. S. Hele-Shaw—Engineering problems affecting prosperity of the country	10	0	0

	£	s.	d.
Section H—Anthropology.			
*Sir C. H. Read—Age of stone circles ...	25	0	0
*Prof. G. Elliot Smith—Physical characters of ancient Egyptians	15	0	0
*Dr. R. R. Marett—Palæolithic site in Jersey	25	0	0
*Prof. J. L. Myres—Archæological investigations in Malta	10	0	0
*Prof. J. L. Myres—Distribution of Bronze age implements	5	0	0
Section I—Physiology.			
*Sir E. Schäfer—Ductless glands ...	20	0	0
*Prof. C. S. Sherrington—Mammalian heart	20	0	0
Section K—Botany.			
*Prof. F. O. Bower—Cinchona Station, Jamaica	12	10	0
*Prof. F. W. Oliver—Structure of fossil plants	2	0	0
*Prof. F. F. Blackman—Heredity ...	45	0	0
Section L—Education.			
*Prof. J. A. Green—Museums	15	0	0
*Dr. G. A. Auden—School books and eyesight	5	0	0
*Dr. C. S. Myers—Mental and physical factors	20	0	0
Mr. C. A. Buckmaster—"Free-place" system	10	0	0
Corresponding Societies Committee.			
*Mr. W. Whitaker—For preparation of report	25	0	0
Total	£968	0	0

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES.

OPENING ADDRESS BY SIR THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S., PRESIDENT OF THE CONFERENCE.

The Organisation of Science.

AMONG the many lessons we learn in every great war, there is always one that stands out prominently as something of fundamental and national importance. In the Crimea our shortcomings in commissariat organisation were demonstrated with painful emphasis. In South Africa we learnt something of the way in which the initiative of the individual, naturally more prominent in the amateur soldier, triumphs, in unforeseen circumstances, over any system fixed by formal and traditional discipline. The great war now in progress will result more completely than any of its puny predecessors in recasting our national ideas, economic, political, and military.

Of all the lessons we are likely to learn, the one that so far promises most to affect the life of the nation may be summed up in a word, *organisation*. The fuss made lately about the shortage of munitions; the discovery in the ranks of the Army and among its officers of thousands who are only amateur fighters but are professionally trained technologists; the recasting of the Cabinet; the introduction, twelve months after the commencement of the war, of legislation to register and classify the technical qualifications of the people; the repeated occurrence of coal strikes on a large scale, settled only by the intervention of Cabinet Ministers, and by an obviously temporary compromise, are all confessions of our shortcomings in national organisation—shortcomings that have already cost the country thousands of lives.

On the other side of the "front" we see organisation raised to the level of a national cult—*Kultur*—with the result that, while efficiency in action and economy in the utilisation of a country's resources have been raised to a standard hitherto unknown, and by us undreamt of, the human instincts have been drilled out of existence, and Germany stands alone as an almost perfect machine in action, but, like a machine, unable to understand the rest of the human race; admired for its mechanical efficiency, but loathed for its degradation of the great human instincts of liberty and toleration.

But between these extremes there must be a course of maximum wisdom; for admittedly both the organisation of the community (the feature which is supposed to dominate the professional classes) and freedom of the individual (the prerogative of the amateur) are necessary for the progress of what is best in civilisation.

Every meeting of the British Association reminds us that early in the last century a body of learned men realised that the form of study popularly known as scientific needed organising, required the strengthening influence of a protective guild—the formation of a cult—in order that its value might be forced on the popular mind. Long before the foundation of the British Association a comparatively small number of men had interested themselves in scientific problems, and their work had so far progressed as to require specialisation, with the foundation of distinct societies. This specialisation found expression at the first three meetings of the association by the formation of committees for (i) Mathematics and General Physics; (ii) Chemistry and Mineralogy; (iii) Geology and Geography; (iv) Zoology and Botany; (v) Anatomy and Physiology; and (vi) Statistics.

These six groups have developed into our present twelve sections and extra subsections, and in practice every section, by classification of its papers and in the conduct of its discussions, acknowledges a further specialisation that is none the less real because it has not been yet formally recognised in organisation.

It is difficult for us to realise that, although the collection of scientific data and thought had made such progress eighty-four years ago as to require the subdivision indicated by the first institution of the British Association, the importance of science was still scarcely recognised among the so-called learned and ruling classes. Obvious if insufficient progress had been made since the days when it was possible for Dean Swift to issue, as tolerable literature, his satires on the Royal Society, or for Robert South to add to his doubtful popularity by describing its members as incapable of admiring anything except "fleas, lice, and themselves."

Although science now takes its place on equal terms with literature in the world of academic culture, we have so far succeeded only to a very small extent in getting the professors of pure science to co-operate in unison with the captains of industry who depend entirely, consciously or otherwise, on the application of scientific laws to industrial problems.

There has hitherto been a tendency for scientific and literary men to gather together under one banner, with the motto "learned," but a more natural association should be indicated by the community of interests between scientific men and technical experts. The student of pure science often discovers laws or formulates theories which are but accidentally carried beyond the purely intellectual world. On the other hand, technical experts frequently work by empirical methods that are discovered either by accident or as

the result of many costly blunders. The growth of science and of commercial technology has been largely independent and unrelated, that is, without organisation.

The absence of this organisation has shown itself for many years to those who are able to read the signs of the times, by the way in which German applied science has assisted commercial activity in trespassing on markets created and formerly occupied by British enterprise. The result of organised co-operation on one hand and of disconnected effort on the other, has now been brought home to us all, suddenly and painfully, by the war. In the utilisation of technical science the German army has had an enormous advantage for which we have had to pay by the lives of some of our best officers and men.

In Germany the scientific, technical, and commercial community (not communities) is mobilised, and each individual in it has been given his appropriate function. In this country, on the other hand, we still have endless instances of right men in wrong places, while scientific activity seems to be devoted to the voluntary formation of innumerable and often irresponsible committees, with overlapping functions and with no apparent common aim in view. Nothing could more clearly demonstrate our shortcomings in organisation than the columns of the daily Press, which are filled with complaints from scientific men who, though among the most distinguished in the world of pure science, are, in this great struggle, still unemployed, and unfortunately often show by the tone of their complaints that they are also unemployable.

A small fraction of the time now devoted in this country to discussion in committee would be sufficient, if turned to well-directed effort, to remove many of the handicaps from which our Navy and Army are now suffering in this critical stage of the war. Most committees might be justifiably likened to two athletes at the east end of a church, discussing the better route by which to get around to the tower, while a cripple starts off at once by one of the routes (possibly even by the less easy of the two); yet the cripple gets there while the athletes are still wrangling.

The root trouble with us is due to the fact that our committees are generally composed of members appointed, not because they are the best able to solve the problem in hand, but because they represent vested interests, and vested interests have now grown to dimensions beyond power of removal, because our institutions are often the products of worthy local, unconnected and therefore unorganised, effort. In their relations to one another, institutions that profess a common public aim show a spirit of jealous competition more prominently than any community of ideal. One cannot study the recent history of university education in London without being painfully impressed with the fact that internal friction in a machine without design results in a consumption of energy that costs more than the educational output is worth.

Our scientific and technical societies similarly suffer from overlapping and conflicting interests, and this conference will be of some value if, instead of discussing for once some special scientific problem, its members become inspired with a desire to direct the activities of the societies they represent so as to reduce the quantity of machinery; to correlate their activities with those of the metropolitan institutions with headquarters in London; to subdivide those institutions composed of dissimilar elements, and to assist, so far as practicable, the regrouping of those who work with common data and with a common aim.

An excellent illustration exists of the way in which reform of this kind is possible when members are sufficiently public-spirited to distinguish between the wider interests of science and those of their own special societies. Up to 1889 there were in this country about eight separate societies devoted to the technical interests mainly of coal mining. In that year four of these societies federated their interests, and during the few following years three others joined the federation and pooled their resources to meet the cost of a common publication and to maintain a common office at Newcastle.

In 1892 the Institution of Mining and Metallurgy was founded in London to meet the wants of technologists devoted mainly to the requirements of metalliferous mining. The rapid growth of this institution, its metropolitan location, and its comprehensive name, challenged the premier position of the Federated Institution of Mining Engineers. The latter consequently changed its name to *The* Institution of Mining Engineers, and moved its central office to London. Thenceforward each institution, not only published papers on its own special branch of mining, but trespassed frequently on the natural domains of its competitor. Later, when one of these institutions applied for a Royal Charter, the other in its own interests successfully opposed the application.

But in 1913, through the happy possession of two presidents who could distinguish parochial from national interests, both institutions agreed to a delimitation of their spheres of influence, and each supported with success the petition of the other for a Royal Charter. They are now no longer competitors, but sister institutions, and, instead of competing for recruits, they can afford to define and maintain a high standard of technical qualification and professional etiquette for the British mining engineer.

One of the first principles observed by a student of science is that of classification. Classification means not merely the bringing together of things that are similar in some essential feature; it also means the separation of those that are essentially unlike, although superficially bearing some form of resemblance.

One realises how hard it is to apply the pruning knife of scientific classification when one contemplates the spectacle of various "literary and philosophical societies" which still survive, mostly under financial difficulties, in many of our large provincial cities, vainly endeavouring to cover "the whole realm of nature." Such societies, embracing the general range of sciences, and sometimes even including literary subjects, exist at Aberdeen (founded in 1840), Birmingham (1858), Cambridge (1819), Edinburgh (1731), Glasgow (1802), Hull (1823), Leeds (1820), Manchester (1781), Newcastle (1793), and York (1822), while at Dublin, where individuality seems ever to flourish in various departments of civilised activity, there are two such societies with, apparently, partly overlapping interests in general science—the Royal Dublin Society, founded in 1731, and the Royal Irish Academy, founded in 1785.

There are not many among these societies the publications of which can be safely neglected by the research worker in any of the specialised branches of science, and yet most of them could not show an average annual output of one serious paper in each of the science subjects as defined by the twelve sections of the British Association. They become in turn the fortunate victims of some local enthusiast, who, in time, passes away like a comet or finds wider scope for his ambitions, either in the Royal Society of London or in the metropolitan society that governs his own pet subject, where his products enjoy the benefit of more thorough discussion, often with appreciation, by fellow-experts.

If we take the Literary and Philosophical Society of this city (which for many years has devoted itself almost entirely to science, and issues memoirs which

no serious worker can afford to overlook) we get an example of the way in which the student is taxed in his search for the "previous literature." Of ninety-one papers published in the Manchester Memoirs during the past five years as many as thirty-four belong to a class that would be referred to Section A of this association, this abundant enthusiasm being largely due to a local occurrence of radio-activity. Of the remainder ten would come under Section B, seven, entirely palæontological in character, come under Section C, twenty-two under D, two under H, two under I, thirteen under K, and one under M.

One can sympathise with those readers who grumble at the one halfpenny-worth of geological bread to this intolerable deal of physical and biological sack.

Now, it is important to remember that this society is maintained by fewer than 150 members, many of whom are members only through general interest in science or merely in consequence of a commendable desire to keep alive an institution which has an honourable record. The critical discussion of most papers presented must therefore be confined to a very small number, and herein arises a danger that may at any time give rise to consequences far more serious than the burial of a paper with an overburden of unrelated literature; for the author of the paper himself must often be the only member capable of deciding as to whether his paper is or is not suitable for record as a definite addition to scientific data or thought.

To the outside student, therefore, the publication of a paper by such a small society gives no *prima facie* reason for regarding it as a serious and probably trustworthy addition to scientific literature. The papers so issued must be most embarrassingly unequal and wholly indeterminate in character; yet no stranger can run the risk of disregarding such publications.

But the tax thus laid on students of scientific literature is not the only drawback or danger due to the activities of such small local non-specialised societies. They often possess collections of natural history specimens or of physical instruments for which they become, by mere possession, trustees to the whole scientific world. As in the case of published literature, the circumstance that these things are often unknown to the rest of the world or are almost inaccessible to the student is only one and not the most serious danger; for one knows instances of collections suffering from neglect, or, still worse, suffering from the activities of some member who temporarily dominates the governing body, and entertains strong views as to the cost of maintaining collections that, from his special point of view, are of no value.

Before proposing, in the name of organisation, to abolish such unspecialised societies, or before even suggesting that they might be allowed to die a natural death, one should exert one's ingenuity to devise some scheme for turning them to account. They inherit traditions in most cases that only an unregenerate iconoclast would despise; most of them were founded when science was barely specialised, and when facilities for attending London meetings were imperfect; many of them have published memoirs that are now of classical value, and have included among their active members the most worthy names in the history of science; most of them possess libraries that could not now be purchased for money, although these are often neglected, and, for financial reasons, often difficult to use.

Even as monuments, therefore, societies such as those that I have mentioned deserve preservation. How, then, can one turn their resources to good account and organise their culture without the drawbacks of *Kultur*?

The plan that has often occurred to me as a possible compromise between the claims of central organisation and provincial autonomy is this. The recognised chief among such societies—the Royal Society of London—should, by affiliation of its provincial poor relations, take over the cost as well as the responsibility of their serious publications. They would enjoy home rule so far as their meetings, discussions, finances, and libraries are concerned; but the papers offered for publication would be censored in the usual way by the appropriate sectional committees of the Royal Society, and, if passed, would be published, either in the Proceedings and Transactions of the Royal or of some metropolitan specialised society. Such papers would then rank technically, not by mere courtesy, as "publications" for purposes of quotation or priority. The local interest in science would not then be curtailed, and the geographical handicap, especially felt by junior provincial workers, would be removed, while the provincial scientific communities would be able to maintain their treasured monuments, without, as now, a constant fear of financial difficulties, and without a recurring dread that senility in the respected old "lit. and phil." will soon end in the way of all things living.

So far as our local example is concerned, many, if not most, of the papers which I have just classified by the B.A. system might well have been accepted by the Royal Society, for the majority of the papers published in its Proceedings are also by non-members. The last six volumes of the Proceedings of the Royal Society contain papers by 384 authors, of whom only 141 are fellows of the society.

I am quite aware of many difficulties in the way of this proposal—fears on the one side that the council of the Royal Society will acquire a dangerous power of controlling the freedom of the scientific writer, and forebodings on the other that the duties of the council threaten to become "heavy burdens and grievous to be borne," while the cost of such additional publications will be removed from the local body only to be thrust upon the Royal Society.

The circumstance that a young worker's paper has been hall-marked by the Royal Society will soon be regarded as fair compensation for what would, after all, be but partial loss of freedom; for the local societies, as well as the various journals, can still publish what they like, though the foreign student may not be blamed for neglecting any but technically published scientific literature.

The extra burdens added to the council and sectional committees of the Royal Society are merely of a kind that someone *must* undertake if we are to have any regard at all for the progress of science, and it will soon be necessary for the State to recognise the national value of the work done by the council and committees of the Royal Society in more ways than nominal recognition of their ornamental positions. In practically every country on the continent of Europe the premier learned academies that occupy positions corresponding to the Royal Society of London are financially supported by the State, and even the ordinary members are paid.

In this country scientific organisations, like the universities, are largely dependent on private charity, with the result that, while we get the benefits of individuality and local competition, we suffer, as the war has already proved to us, the necessary loss of power due to an undesirable number of wheels in our machine, due to unnecessary duplication of effort, and due to industrial and financial eddies in the stream of progress; in a word, due to want of method and organisation. That is the theme which I wish the delegates present to take back for practical consideration by the societies that we represent.

It is important to remember that organisation necessarily requires someone to take the lead and someone to fill the subordinate's place; otherwise, all is anarchy, and whatever may be the discipline within each society, their relations to one another at present can but be described as anarchy; the fellow of the Royal Society has no more responsibility at present than any member of the smallest debating club; his selection is regarded as an honour, but an honour is as meaningless as an iron cross if it does not imply responsibility and an opportunity for more work. What applies to an individual applies to a society of such persons. The premier position of the Royal Society is acknowledged by every British worker in science, and those societies which similarly embrace all phases of science can assist the aims of organisation by reminding the Royal Society that its position is more than ornamental, and that its lead will be welcomed.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. W. M. BAYLISS, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

The Physiological Importance of Phase Boundaries.

EVEN a hasty consideration of the arrangements present in living cells is sufficient to bring conviction that the physical and chemical systems concerned operate under conditions very different from those of reactions taking place between substances in true solution. We become aware of the fact that there are numerous constituents of the cell which do not mix with one another. In other words, the cell system is one of many "phases," to use the expression introduced by Willard Gibbs.

Further, parts of this system which appear homogeneous under the ordinary microscope are shown by the ultra-microscope to be themselves heterogeneous. These are in what is known as the colloidal state. Some dispute has taken place as to whether this state is properly to be called a heterogeneous one, but it is sufficient for our purpose to note that investigation shows that the interfaces of contact between the components of such systems are the seat of the various forms of energy which we meet with in the case of systems obviously consisting of phases which can be separated mechanically, so that considerations applying to coarsely heterogeneous systems apply also to colloidal systems. Although the phases of a colloidal system cannot be so obviously and easily separated as those of an ordinary heterogeneous one, this can be done almost completely by filtration through membranes such as the gelatin in Martin's process. To avoid confusion, however, it has been suggested that the colloidal state should be spoken of as "micro-heterogeneous." There are, in fact, certain phenomena more or less peculiar to the colloidal state and due to the influence of the sharp curvature of the surfaces of the minutely subdivided phase. The effect of this curvature is a considerable pressure in the interior of the phase, owing to the surface tension, and it adds further complexity to the properties manifested by it.

We see, then, that the chemical reactions of chief importance to us as physiologists are those known as "heterogeneous." This class of reactions, until comparatively recent times, has been somewhat neglected by the pure chemist.

In some of its aspects, the problem before us was discussed by one of my predecessors, Prof. Hopkins, as also by Prof. Macallum, but its importance will, I think, warrant my asking your indulgence for a further brief discussion. Permit me first to apologise for what may seem to some of those present to be an unnecessarily elementary treatment of certain points.

It is easy to realise that the molecules which are situated at the interface where two phases are in contact are subject to forces differing from those to which the molecules in the interior of either phase are subject. Consider one phase only, the molecules at its surface are exposed on the one side to the influence of similar molecules; on the other side, they are exposed to the influence of molecules of a nature chemically unlike their own or in a different physical state of aggregation. The result of such asymmetric forces is that the phase boundary is the seat of various forms of energy not present in the interior of the phase. The most obvious of these is the surface energy due to the state of tension existing where a liquid or a gas forms one of the phases. It would lead us too far to discuss the mode of origin of this surface tension, except to call to mind that it is due to the attractive force of the molecules for one another, a force which is left partially unbalanced at the surface, so that the molecules here are pulled inwards. The tension is, of course, only the intensity factor of the surface energy, the capacity factor being the area of the surface. We see at once that any influence which alters the area of the surface alters also the magnitude of that form of energy of which we are speaking.

This is not the only way in which the properties of substances are changed at phase boundaries. The compressibility of a solvent, such as water, are altered, so that the solubilities of various substances in it are not the same as in the interior of the liquid phase. It is stated by J. J. Thomson that potassium sulphate is 60 per cent. more soluble in the surface film. The ways in which the properties of a solvent are changed are sometimes spoken of as "lyotropic," and they play an important part in the behaviour of colloids. We meet also with the presence of electrical charges, of positive or negative sign. These are due, as a rule, to electrolytic dissociation of the surface of one phase, in which the one ion, owing to its insolubility, remains fixed at the surface, while the opposite ion, although soluble, cannot wander away further than permitted by electrostatic attraction. Thus we have a Helmholtz double layer produced.

Before we pass on to consider how these phenomena intervene in physiological processes, there is one fact that should be referred to on account of its significance in connection with the contractile force of muscle. Surface tension is found to *decrease* as the temperature rises, or, as it is sometimes put, it has a negative temperature coefficient. This is unusual; but, if we remember that the interface between a liquid and its vapour disappears when the temperature rises to the critical point, and with it, of course, all phenomena at the boundary surface, the fact is not surprising that there is a diminution of these phenomena as the critical temperature is approached.

Perhaps that result of surface energy known as "adsorption" is the one in which the conditions present at phase boundaries make themselves most frequently obvious. Since the name has been used somewhat loosely, it is a matter of some consequence to have clear ideas of what is meant when it is made use of. Unless it is used to describe a definite fact, it can only be mischievous to the progress of science.

Permit me, then, first to remind you of that fact of universal experience, known as the "dissipation of energy," which is involved in the second law of energetics. Free energy—that is, energy which can be used for the performance of useful work—is in-

variably found to diminish, if the conditions are such that this is possible. If we have, therefore, a system in which, by any change of distribution of the constituents, free energy can be decreased, such a change of distribution will take place. This is one form of the well-known "Principle of Carnot and Clausius."

Now, practically any substance dissolved in water lowers the surface tension present at the interface between the liquid and another solid or liquid phase with which it is in contact. Moreover, up to a certain limit, the magnitude of this effect is in proportion to the concentration of the solute. Therefore, as was first pointed out by Willard Gibbs, concentration of a solute at an interface has the effect of reducing free energy and will therefore occur. This is adsorption. As an example, we may take the deposition of a dye-stuff on the surface of charcoal, from which it can be removed again, unaltered, by appropriate means, such as extraction with alcohol. Charcoal plus dye may, if any satisfaction is derived from the statement, be called a compound. But, since its chemical composition depends on the concentration of the solution in which it was formed, it is much more accurate to qualify the statement by calling it an "adsorption-compound." Moreover, the suggestion that the union is a chemical one tends to deprive the conception of chemical combination of its characteristic quality, namely, the change of properties. Dye-stuff and charcoal are chemically unchanged by adsorption.

The origin of adsorption from surface tension is easily able to explain why it is less as the temperature rises, as we find experimentally. As we have just seen, surface tension diminishes with increase of temperature.

Let us next consider what will happen if the liquid phase contains in solution a substance which lowers surface tension and is also capable of entering into chemical reaction with the material of which the other, solid, phase consists. For example, a solution of caproic acid in contact with particles of aluminium hydroxide. On the surface of the solid, the concentration of the acid will be increased by adsorption, and, in consequence, the rate of the reaction with it will be raised, according to the law of mass action. Further, suppose that the liquid phase contains two substances which react slowly with each other, but not with the solid phase. They will be brought into intimate contact with each other on the surface of the solid phase, their concentration raised and the rate of their interaction increased. One of the reagents may clearly be the solvent itself. But in all these cases the rate of the reaction cannot be expressed by a simple application of the law of mass action, since the active masses are not functions of the molecular concentrations, but of the surface of the phase boundaries. The application of these considerations to the problem of the action of enzymes and of heterogeneous catalysis in general will be apparent. That the action of enzymes is exerted by their surfaces is shown, apart from the fact that they are in colloidal solution, by the results of experiments made in liquids in which the enzymes themselves are insoluble in the usual sense, so that they can be filtered off by ordinary filter paper and the filtrate found to be free from enzyme. Notwithstanding this insolubility, enzymes are still active in these liquids. The statement has been found, up to the present, to apply to lipase, emulsin, and urease, probably to trypsin, and the only difficulty in extending it to all enzymes is that of finding a substrate soluble in some liquid in which the enzyme itself is not. That adsorption is a controlling factor in the velocity of enzyme action has been advocated by myself for some years, but it is not to be understood as implying that the whole action of enzymes is an "adsorption phenomenon," whatever may be the meaning of this statement. The rate at which the chemical reaction proceeds is controlled by the mass of the reagents concentrated on the surface of the enzyme phase at any given moment, but the temperature coefficient will, of course, be that of a chemical reaction.

The thought naturally suggests itself, may not the adsorption of the reacting substances on the surface of the enzyme suffice in itself to bring about the equilibrium at a greater rate, so that the assumption of a secondary chemical combination of a chemical nature between enzyme and substrate may be superfluous? I should hesitate somewhat to propose this hypothesis for serious consideration were it not that it was given by Faraday as the explanation of one of the most familiar cases of heterogeneous catalysis, namely, the union of oxygen and hydrogen gases by means of the surfaces of platinum and other substances. The insight shown by Faraday into the nature of the phenomena with which he was concerned is well known and has often caused astonishment. Now, this case of oxygen and hydrogen gases is clearly one of those called "catalytic" by Berzelius. The fact that the agent responsible for the effect did not itself suffer change was clear to Faraday. I would also, in parenthesis, direct attention to the fact that he correctly recognised the gold solutions which he prepared as suspensions of metallic particles—that is, as what we now call colloidal solutions. Although the systematic investigation of colloids, and the name itself, were due to Graham, some of the credit of the discovery should be given to the man who first saw what was their nature. Adsorption, again, was accurately described by Faraday, but without giving it a name.

I confess that there are, at present, difficulties in the way of accepting concentration by adsorption as a complete explanation of the catalytic activities of enzymes. It is not obvious, for example, why the same enzyme should not be able to hydrolyse both maltose and saccharose, as it is usually expressed. Another difficulty is that it is necessary to assume that the relative concentration of the components of the chemical system must be the same on the surface of the enzyme as it is in the body of the solution; in other words, the adsorption of each must be the same function of its concentration. Unless this were so, the equilibrium position on the enzyme surfaces, and therefore in the body of the solution, would be a different one under the action of an enzyme from that arrived at spontaneously or brought about by a homogeneous catalyst such as acid. This consideration was brought to my notice by Prof. Hopkins, and requires experimental investigation. We know, indeed, that in some cases there is such a difference in the position of the equilibrium position, for which various explanations have been suggested. But it would be a matter of some interest to know whether this difference has any relation to different degrees of adsorption of the components of the system.

At the same time, adsorption is under the control of so many factors, surface tension, electrical charge, and so on, that the possibilities seem innumerable. There are, moreover, two considerations to which I may be allowed to direct your attention. Hardy has pointed out that it is probable that the increased rate of reaction at the interface between phases may be due, not merely to increased concentration as such, but that in the act of concentration itself molecular forces may be brought into play which result in a rise in chemical potential of the reacting substances. In the second place, Barger has shown that the adsorption of iodine by certain organic compounds is clearly related to the chemical composition of the surfaces of these substances, but that this relationship does not result in

chemical combination or in abolition of the essential nature of the process as an adsorption. It would appear that those properties of the surface, such as electric charge and so on, which control the degree of adsorption, are dependent on the chemical nature of the surface. This dependence need not cause us any surprise, since the physical properties of a substance, inclusive of surface tension, are so closely related to its chemical composition.

There is one practical conclusion to be derived from the facts already known with regard to enzymes. This is, that any simple application of the law of mass action cannot lead to a correct mathematical expression for the rate of reaction, although attempts of this kind have been made, as by Van Slyke. The rate must be proportional to the amount of substrate adsorbed, and this, again, is a function both of the concentration of the substrate and of that of the products. It is, then, a continuously varying quantity. Expressed mathematically, the differential equation for the velocity must be something of this kind :—

$$\frac{dC}{dt} = KC^n$$

where n itself is an unknown function of C, the concentration of the substrate or products.

The hypothesis of control by adsorption gives a simple explanation of the exponential ratio between the concentration of the enzyme and its activity, which is found to be different numerically according to the stage of the reaction. At the beginning, it may be nearly unity; in the middle it is more nearly 0·5, as in the so-called 'square root law' of Schütz and Borissov, which is, however, merely an approximation. Simple explanations are also given of the fact that increasing the concentration of the substrate above a certain value no longer causes an increased rate of reaction. This is clearly because the active surface is saturated. Again, the effect of antiseptics and other substances which, by their great surface activity, obtain possession of the enzyme surfaces, and thereby exclude to a greater or less degree the adsorption of the substrate, receives a reasonable account. In many cases, the depressant or favouring action of electrolytes, including acid and alkali, is probably due to aggregation or dispersion of the colloidal particles of the enzyme, with decrease or increase of their total surface. It is to be noted that such explanations are independent of any possible formation of an intermediate compound between enzyme and substrate, *after* adsorption has taken place.

There is a further way in which adsorption plays a part in the chemical processes of cells, including those under the influence of catalysts. It is a familiar fact that the concentration of water plays a large part in the position of equilibrium attained in reversible reactions of hydrolysis and synthesis. A synthetic process is brought about by diminution of the effective concentration of water. There are, doubtless, means of doing this in the elaborate mechanisms of cell life, and, in all probability, it is by adsorption on surfaces, which are able to change their "affinity" for water.

I pass on to consider briefly some other cases in which the phenomena at phase boundaries require attention.

Let us turn our gaze from the interior of the cell to the outer surface, at which it is in contact with the surrounding medium. From the nature of adsorption there can be no doubt that, if the cell or the surrounding liquid contains substances which decrease surface energy of any form, these constituents will be concentrated at the interface. There are many such substances to be found in cells, some of lipoid nature, some proteins, and so on. Further, the experiments of Ramsden have shown that a large number of substances are deposited in surface films in a more or less rigid or solidified form. We are thus led to inquire whether these phenomena do not account for the existence of the cell membrane, about which so much discussion has taken place. We find experimentally that there are facts which show that this membrane, under ordinary resting conditions, is impermeable to most crystalloids, including inorganic salts, acids, and bases. There is no other explanation of the fact that the salts present in cells are not only in different concentration inside from that outside, but that there may be absence of certain salts from one which are present in the other, as, for example, sodium in the plasma of the rabbit not in the corpuscles. Moreover, the experiments of Hoeber have shown that electrolytes are free in the cells, so that they are not prevented from diffusion by being fixed in any way. The mere assumption of a membrane impermeable to colloids only will not account for the facts, since, as I have shown in another place, this would only explain differences of concentration, but not of composition. The surface concentration of cell constituents readily accounts for the changes of permeability occurring in functional activity, since it depends on the nature of the cell protoplasm, and chemical changes of many and various kinds occur in this system. If such be the nature of the cell membrane, it is evident that we are not justified in expecting to find it composed of lipoid or of protein alone. It must have a very complex composition, varying with the physiological state of the cell. Indeed, complex artificial membranes have been prepared having properties very similar to that of the cell.

This view that the membrane is formed by surface condensation of constituents of the cell readily accounts for the changes of permeability occurring in functional activity, since its composition depends on that of the cell protoplasm, and chemical changes of various kinds take place in this system, as it is scarcely necessary to remind you. In fact, the cell membrane is not to be regarded as an independent entity, but as a working partner, as it were, in the business of the life of the cell. In the state of excitation, for example, there is satisfactory evidence that the cell membrane loses its character of semi-permeability to electrolytes, etc. This statement has been shown to apply to muscle, nerve, gland cells, and the excitable tissues of plants, as well as to unicellular organisms. We shall see presently how this fact gives a simple explanation of the electrical changes associated with the state of activity.

If, then, the cell membrane is a part of the cell system as a whole, it is not surprising to find that substances can affect profoundly, although reversibly, the activities of the cell, even when they are unable to pass beyond the outer surface. The state of dynamic equilibrium between the cell membrane and the rest of the cell system is naturally affected by such means, since the changes in the one component involve compensating ones in the other. Interesting examples of such actions are numerous. I may mention the effect of calcium ions on the heart muscle, the effect of sodium hydroxide on oxidation in the eggs of the sea-urchin, and that of acids on the contraction of the jelly-fish. Somewhat puzzling are those cases in which drugs, such as pilocarpine and muscarine, act only during their passage through the membrane and lose their effect when their concentration has become equal inside and outside the cell.

The work of Dale on anaphylaxis leads him to the conclusion that the phenomena shown by sensitised plain muscle can most reasonably be explained by colloidal interaction on the surface of the fibres. The

result of this is increased permeability and excitation resulting therefrom.

I referred previously to the electrical change in excitable tissues and its relation to the cell membrane. It was, I believe, first pointed out by Ostwald and confirmed by many subsequent investigators, that in order that a membrane may be impermeable to a salt it is not a necessary condition that it shall be impermeable to both the ions into which this salt is electrolytically dissociated. If impermeable to one only of these ions, the other, diffusible, ion cannot pass out beyond the point at which the osmotic pressure due to its kinetic energy balances the electrostatic attraction of the oppositely charged ion, which is imprisoned. There is a Helmholtz double layer formed at the membrane, the outside having a charge of the sign of the diffusible ions, the inside that of the other ions. Now, suppose that we lead off from two places on the surface of a cell having a membrane with such properties to some instrument capable of detecting differences of electrical potential. It will be clear that we shall obtain no indication of the presence of the electrical charge, because the two points are equipotential, and we cannot get at the interior of the cell without destroying its structure. But if excitation means increased permeability, the double layer will disappear at an excited spot owing to indiscriminate mixing of both kinds of ions, and we are then practically leading off from the interior of the cell, that is, from the internal component of the double layer, while the unexcited spot is still led off from the outer component. The two contacts are no longer equipotential. Since we find experimentally that a point at rest is electrically positive to an excited one, the outer component must be positive, or the membrane is permeable to certain cations, impermeable to the corresponding anions. Any action on the cell such as would make the membrane permeable, injury, certain chemical agents, and so on, would have the same effect as the state of excitation. If we may assume the possibility of degrees of permeability, the state of inhibition might be produced by *decrease* of permeability of the membrane of a cell, which was previously in a state of excitation owing to some influence inherent in the cell itself or coming from the outside. This manner of accounting for the electromotive changes in cells is practically the same as that given by Bernstein.

It will be found of interest to apply to secretory cells the facts to which I have directed your attention. If we suppose that the setting into play of such cells is associated with the production of some osmotically active substance, together with abolition of the state of semi-permeability of the membrane covering the ends of the cells in relation with the lumen of the alveolus of the gland, it is plain that water would be taken up from the lymph spaces and capillaries and escape to the duct, carrying with it the secretory products of the cells. This process would be continuous so long as osmotically active substances were formed. Such a process has been shown by Lepeshkin to occur in plants, and we have also evidence of increased permeability during secretory activity in the gland cells of animals. From what has been said previously, it is evident that electrical differences would show themselves between the permeable and semi-permeable ends of such cells, as has been found to be the case.

As a modifiable structure, we see the importance of such a membrane as that described if it takes part in the formation of the synapse between neurones. The manifold possibilities of allowing passage to states of excitation or inhibition and of being affected by drugs will be obvious without further elaboration on my part.

Enough has already been said, I think, to show the innumerable ways in which phenomena at phase boundaries intervene in physiological events. Indeed, there are very few of these, if any, in which some component or other is not controlled by the action of surfaces of contact. But there is one especially important case to which I may be allowed to devote a few words in conclusion. I refer to the contractile process of muscle. It has become clear, chiefly through the work of Fletcher, Hopkins, and A. V. Hill, that what is usually called muscular contraction consists of two parts. Starting from the resting muscle, we find that it must have a store of potential energy, since we can make it do work when stimulated. After being used in this way, the store must be replenished, since energy cannot be obtained from nothing. This restoration process is effected by an independent oxidation reaction, in which carbohydrate is burnt up with the setting free of energy which is made use of to restore the muscle to its original state. Confining our attention for the moment to the initial, contractile, stage, the essential fact is the production of a certain amount of energy of tension, which can either be used for the performance of external work or be allowed to become degraded to heat in the muscle itself. It was Blix who first propounded the view that the amount of this energy of tension is related to the magnitude of certain surfaces in the muscle fibres. But the fact was demonstrated in a systematic and quantitative manner by A. V. Hill. He showed, in fact, that the amount of energy set free in the contractile process is directly related to the length of muscle fibres during the development of the state of tension. In other words, the process is a surface phenomenon, not one of volume, and is directly proportional to the area of certain surfaces arranged longitudinally in the muscle. This same relationship has been shown by Patterson and Starling to hold for the ventricular contraction of the mammalian heart and by Kosawa for that of the cold-blooded vertebrate. It appears that all the phenomena connected with the output of blood by the heart can be satisfactorily explained by the hypothesis that the energy of the contraction is regulated by the *length* of the ventricular fibres during the period of development of the contractile stress. The degree of filling at the moment of contraction is thus the determining factor.

That surface tension itself may be responsible for the energy given off in muscular contraction was first suggested by Fitzgerald in 1878, and it seems, from calculations made, that changes at the contact surface of the fibrillæ with the sarcoplasm may be capable of affording a sufficient amount. The difficulties in deciding the question are great, but, in addition to the facts mentioned, there is other interesting evidence at hand. It has been shown, by Gad and Heymans, by Bernstein and others, that the contractile stress produced by a stimulus has a negative temperature coefficient. Within the limits of temperature between which the muscle can be regarded as normal, this stress is the greater the lower the temperature. The same statement was shown by Weizsäcker (working with A. V. Hill) to hold for the heat developed in the contractile stage. Now, of all the forms of energy possibly concerned, that associated with phase boundaries is the only one with a negative temperature coefficient. Another aspect of this relation to temperature is the well-known increase of the tonus of smooth muscle with fall in temperature.

It is tempting to bring into relation with the change in surface tension the production of lactic acid. In fact, this idea was put into a definite statement by Haber and Klemensievich in 1909 in a frequently quoted paper on the forces present at phase boundaries.

The production of acid is stated to alter the electrical forces at this situation. This electrical charge involves a change of surface tension, and it is this change of surface tension which brings about the mechanical deformation of the muscle. Mines also has brought forward good evidence that the production of lactic acid is responsible for the change of tension. As to how the lactic acid is set free, and of what nature the system of high potential present in muscle may be, we require much more information. The absence of evolution of carbon dioxide when oxygen is not present shows that no oxidation takes place in the development of tension. There are other difficulties also in supposing that this system present in resting muscle is of a chemical nature. If the energy afforded by the oxidation of carbohydrate in the recovery stage is utilised for the formation of another chemical system with high energy content, the theory of coupled reactions indicates that there must be some component common to both systems. It is difficult to see what component of the muscle system could satisfy the conditions required. On the whole, some kind of system of a more physical nature seems the most probable. If it be correct that the oxidation of substances other than carbohydrate, fat, for example, can afford the chemical energy for muscular contraction, as appears from the results of metabolism experiments, a further difficulty arises in respect to a coupled reaction. But the question still awaits investigation.

On the whole, I think that we may conclude that more study of the phenomena at phase boundaries will throw light on many problems still obscure. It would probably not be going too far to say that the peculiarities of the phenomena called "vital" are due to the fact that they are manifestations of interchange of energy between the phases of heterogeneous systems. It was Clerk Maxwell who compared the transactions of the material universe to mercantile operations in which so much credit is transferred from one place to another, energy being the representative of credit. There are many indications that it is just in this process of change of energy from one form to another that special degrees of activity are to be observed. Such, for example, are the electrical phenomena seen in the oxidation of phosphorus or benzaldehyde, and it appears that, in the photo-chemical system of the green plant, radiant energy is caught on the way, as it were, to its degradation to heat, and utilised for chemical work. In a somewhat similar way, it might be said that money in the process of transfer is more readily diverted, although perhaps not always to such good purpose as in the chloroplast. Again, just as in commerce money that is unemployed is of no value, so it is in physiology. Life is incessant change or transfer of energy, and a system in statical equilibrium is dead.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY MRS. HENRY SIDGWICK, PRESIDENT OF THE SECTION.

WHEN I look at the names of many of my predecessors in this presidential chair, when I read their addresses, or when I consider what the work of the Section ought to be, I feel that an apology is needed for my being here at all.

Let me say at once, however, that it is not because of my being a woman that I feel this. It is true that I am the first woman who has had the honour of presiding over Section L. But it is obviously very fitting that a woman should sometimes do so; and this not only because women are as much concerned with the results of educational science as men are—that might be said about all departments of science; nor only because the material on which education works—the human material to be educated—is approximately evenly divided between the sexes. A more important consideration is that women have the largest share in the work of education. This is clear if we take education in its widest and fullest sense, and include in it what is done in the home as well as in the school, beginning as it must with the earliest infancy. But it is also true if we limit the meaning of the word education—in the way that is constantly done, and is I think usually done in the discussions that take place in this Section—to that part of it with which the professional educator, the school or college teacher, is concerned. For the fact that the school teaching, not only of girls, but of the younger children of both sexes, is mainly in the hands of women, results of necessity in there being a larger number of professional teachers among women than among men.

May it not be added that in some departments of education women have appeared to take their profession more seriously than men so far as this can be measured by the trouble taken in training for it? For I think I am right in saying that among persons proposing to teach in secondary schools more women in proportion than men have hitherto availed themselves of opportunities for professional training.

From another point of view, too, the education of women and girls has an interest which, though not different in kind, is greater in degree than that of the other sex. I mean in the rapidity of its growth and development since the middle of the last century. The development of school and university education and of technical education has, of course, been very great for both sexes. Much attention has been devoted to improving its quality, and perhaps even more to increasing its quantity, by making it more accessible to all classes of people. But in the case of girls and women the progress has been greater and more remarkable than in that of boys, for it started from a lower level, and notwithstanding this it would, I think, be difficult to point out in what respects the educational opportunities of women are now inferior to those of men. I say this, of course, in a general sense, and without prejudice as to controversial questions of detail such as the merits of the methods and curricula deliberately adopted for different schools.

The Report of the Schools Inquiry Commission published in 1868, in what it says about girls' education at that time, gives us a standard of comparison and a means of estimating the progress made. It has often been quoted, but may bear quoting again. The Commissioners say:[1]

"The general deficiency in girls' education is stated with the utmost confidence, and with entire agreement, with whatever difference of words, by many witnesses of authority. Want of thoroughness and foundation; want of system; slovenliness and showy superficiality; inattention to rudiments; undue time given to accomplishments, and those not taught intelligently or in any scientific manner; want of organisation—these may sufficiently indicate the character of the complaints we have received, in their most general aspect. It is needless to observe that the same complaints apply to a great extent to boys' education. But on the whole the evidence is clear that, not as they might be, but as they are, the girls' schools are inferior in this view to the boys' schools."

This was what could be said of schools in 1868, and is certainly in striking contrast to what could be said now. And if we turn from the schools to higher education we find this was practically non-existent for women at that time. Its absence was indeed one

[1] Report of the Schools Inquiry Commission, p. 548.

cause of the badness of the schools. The schools were bad because the teachers were inadequately educated. "The two capital defects of the teachers of girls," as one of the Assistant Commissioners (Mr. Bryce, now Lord Bryce) reported, "are these: they have not themselves been taught and they do not know how to teach." These defects were, of course, partly due to the badness of the schools, and the want of any standard enabling the general public and the teachers themselves to judge of their badness. So far it was a vicious circle. The teachers were badly taught in bad schools and handed on the bad results to the schools they later taught in. But the defects were partly due to the absence of opportunity for them to carry their own education beyond that of their elder pupils—to obtain that higher education which men obtained at the universities. This was pointed out by the Commissioners, and their report acted as a great help and encouragement to those who had already realised the need of higher education for women, and gave an important stimulus to the foundation of colleges for women, first at Cambridge and then at Oxford.

The Commissioners' report also greatly encouraged the movement already in progress for the improvement of girls' schools—the movement in which Miss Buss, of the North London Collegiate School, and Miss Beale, of the Cheltenham Ladies' College, were among the pioneers, and in which the opening of local examinations to girls in 1865 by Cambridge was an important step. The cautious and anxious way in which the Commissioners refer to the possible effects on girls of more exacting school work and of examinations is amusing to read now. But the report of the Commission helped in the progress of girls' education in still another way, for it was instrumental in securing the recovery for the secondary education of girls of endowments which had been allowed to lapse into the service of primary education or to be absorbed by boys; and the division between girls and boys of some endowments not specifically assigned to either sex by the founders. Twenty years ago—in 1895—the Charity Commissioners in their annual report gave striking testimony to what has been done both in this way and by new endowments:—

"There is reason to think," they said, "that the latter half of the nineteenth century will stand second in respect of the greatness and variety of the charities created within its duration to no other half-century since the Reformation. And, as to one particular branch of educational endowment, namely, that for the advancement of secondary and superior education of girls and women, it may be anticipated that future generations will look back to the period immediately following upon the Schools Inquiry Commission and the consequent passing of the Endowed Schools Acts, as marking an epoch in the creation and application of endowments for that branch of education similar to that which is marked, for the education of boys and men, by the Reformation."

And the flow of endowments for this branch of education has not ceased since the report just quoted from was written. As examples of it I may remind you of the St. Paul's Girls' School, the extension and rebuilding of Bedford College, University of London, and the large sums given for the domestic department of King's College for Women.

Though, however, as the Charity Commissioners say, a great impulse was given to girls' education by the report of the Schools Inquiry Commission and the legislation as regards endowments that followed, I think that, even without these, great progress would have been made, though probably less rapidly. The desire for it was already there. Women who had themselves suffered from the previous deficiency were working for improvement, and sympathetic men friends were helping. It was becoming more and more obvious not only that women teachers must have adequate opportunities of learning, but that the home no longer in itself afforded sufficient scope for the energies of the daughters, especially unmarried daughters, of the professional classes, and that they must be trained for other useful work. The supply of suitable education followed the demand, as generally happens when the demand is strong and clear. The very mention by the Charity Commissioners in the passage I have quoted of the *creation* as well as of the *application* of endowments for the purposes of female education is evidence of the active public interest in the matter. The spirit which has led during the last half-century to the liberal endowment of education for girls and women from private sources has also led the State, and public bodies generally, to consider girls equally with boys in all public administration of education or of educational funds. The same spirit has led the newer universities without exception to admit women to their benefits on equal terms with men. And at the same time the creation of some professions and skilled industries—*e.g.* sick nursing—by women, and the opening to them of others, together with the general movement in favour of professional training for professional work, have led to the great development of opportunities of technical or vocational training for women as well as for men.

This immense—almost revolutionary—change, as regards educational opportunities for women, which has occurred within the recollection of people of my age, and which must be attributed largely to the efforts of women themselves, is, I think, very striking; and it certainly, as I said, fully justifies the selection of a woman to preside over the Educational Section of the British Association. The apology I feel to be needed is for the particular woman selected. For it is the science of education, or at any rate the science and art of education, that this Section presumably exists to advance, and I am no educator, no teacher; I have made no psychological study of young people from an educational point of view, nor of the different methods of teaching suited to different ages, no statistical investigation of the influence or particular curricula in training the mind or furnishing it with useful information. I have, in short, neither made contributions to the science of education nor practised the art. Any work I have done has been on the administrative side, and I can speak only as a member of the general public—not as an expert. And what is there new, in a subject so much discussed, for a member of the general public to say? An illuminating address is, I fear, in the circumstances impossible.

Not that I regard the view of the general public as unimportant. Indeed, I am not sure that a good case could not be made out for having a mere member of the general public as such as president from time to time. The general public must, as all will admit, decide what is to be spent on education, or, more strictly, on schools and colleges and professional educators, out of both public and private income—it is for them to decide on its relation to other social and family needs. But the concern of the public with education is not merely financial and administrative. It is more intimate than that. For education is not a subject like physics or chemistry on which only an expert has a right to an independent view. There are, no doubt, aspects of it of which only the expert can properly judge, there are experiments in it which only the expert can advantageously try, and there are, of course, departments of it in which the opinion of the expert is indispensable. But without depreciating either the science or art of education, it is clear that

when we take education in its widest sense it concerns everybody, and almost everybody is bound to have views about it. Each generation as a whole is responsible for handing on to the next the control over matter and mind, and the power of co-operation, which it has itself inherited from its forbears and added to, and which it must put its successors in a position to add to further. It is on this that the progress of the human race depends; without it each generation would have to start afresh from the beginning, and we should still be in the position of primitive man.

But the larger and more important part of education in this wide sense is done first in the nursery, and then, as the child gets beyond babyhood, by means of its own observation and imitation of its elders; while much is done by experience gained in mixing with others of its own age, and much by the exercise of responsibility. The education thus obtained, combined with precepts and with tales handed down orally, sufficed for our ancestors until the increasing complexity of life made it important for the rising generation to acquire skill and knowledge which mere imitation and experience could not give. When this happened division of labour took place in this as in other departments of life, and led to the introduction of the professional educator—that is, the educational expert who has the art of imparting the needed knowledge and skill, or at least of shortening the process of acquiring them. We may observe that his services are now required by all, and not, as was once the case, only by those preparing for the learned professions. This work of the professional educator is what our Section of the British Association is mainly concerned with, and the methods to be employed are best judged by the professional educators themselves. But the co-ordination of their work with the whole process of education, its place in the production of good citizens, must, as I have said, be judged, not by the professional educators alone, but by the whole body of the nation. The general public must not only be regarded as capable of exercising judgment on educational matters, but should be encouraged to feel that it is its duty to do so.

If we judge by the amount of talk which goes on about education, it would perhaps seem that the public is fully aware of its responsibilities. And yet I think there are indications that in some respects it fails to grasp them, and is disposed to depend too much on the professional educator; allowing itself to be confused by our habit of using the same word "education" in both the wider sense, of which we have been speaking, and also in the narrower sense of book-learning. The sense of proportion seems to me to be sometimes seriously lost from this cause.

I was impressed with an example of this exhibited a little while ago in a correspondence in the *Times* about the employment of the older boys in the elementary schools of country districts to do some of the work on the farms in place of farm-hands who have enlisted. One group of the correspondents, looking at the question from the point of view of agriculture, thought the advantage derived by the boy from his last year of school training was of small value to the country compared with the work he could do on the farm. The other group, looking at the question from the point of view of the school, thought it monstrous that what they called the "education" of the boy should be in any way curtailed. I am not at the moment concerned with the controversy itself, nor am I taking the side of either group of disputants. There is, of course, much to be said on both sides, and the decision should probably vary with the locality, and the work, and the farmer, and the boy. But what struck me was that all the disputants seemed to regard education as beginning and ending at school. None appeared to think of it in its wider sense. None referred to the great effect it might have on the boy's future life and character to feel that in a grave national crisis he had "done his bit"—an effect which would perhaps be all the greater if he felt he was sacrificing something to make up for which special effort might be needed later. I have seen the view of the gain to boys and girls from helping in the emergency put forward since, but not in the particular newspaper controversy in question, nor, I think, in connection with the loss of a year of schooling.

And there was another aspect of the question which did not seem to excite attention. I mean the possibly bad educational effect, in the wide sense, of preventing the boy from doing the work. To keep him at school, if he was conscious that his services were needed elsewhere, could not but tend to concentrate his attention on himself and the importance of his own schooling, and could not but tend to produce to some extent the deplorable temper of mind which leads some young people, a little older than the schoolboys over whom the controversy raged, to regard self-development as the aim and object of existence. This is certainly not the attitude of a good citizen—and to produce good citizens should, as we probably all agree, be the principal aim of education.

The particular difficulty to which I have referred seems inseparable from compulsory education, and probably cannot be altogether got over. The thoughtful girl of twelve, not absorbed in herself, must sometimes wonder whether her school-work is really as valuable as the help she could give her mother in some special difficulty or strain, except on the assumption that her own development ranks above all other objects.

Of course, the higher the relative value we put on scholastic education the less important will the loss of other educational influences appear to us. And perhaps at this point I had better frankly confess—what is, I fear, another defect in my qualifications as president of the Educational Section—namely, that I am not an enthusiast about education in the same sense that most of my hearers probably are. I read the other day in a review of the life of an American educationist that—

"He was penetrated with two characteristics which are the saving clause of the American and every other democracy, a reverence for learning and a flaming belief in education as the condition of success in any scheme of popular self-government."

In the reverence for learning I am with him, but I could not describe my belief in education—education, that is, in the sense here meant, namely, school and college education—as "flaming." I cannot, for instance, believe, as some seem to do, that by keeping children a year longer at school we should regenerate mankind, or at least secure as a matter of course great improvement. Why, you may ask, if I am not an enthusiastic believer in education, have I spent so much of my life—my time, my energy, my means—in helping to provide opportunities of university education for women? The answer is that I do believe very much in giving to as many people as possible educational opportunities—meaning by that in the first place the means of preparing for their work in life. Those who are going to teach, for instance, must obviously learn first, and, as I have just reminded you, women's opportunity of doing this was lamentably deficient half a century ago.

But secondly—and this is not at all less important—I mean by educational opportunity the means of satisfying intellectual curiosity, every spark of which should be fostered. For it is to intellectual curiosity that progress in knowledge, including physical science,

is mainly due. And intellectual curiosity is an important adjunct to the mental processes involved in understanding the world we live in, a valuable aid in the formation of a good judgment, and a great assistance in practical life. Intellectual curiosity and æsthetic sensibility are, moreover, the mainsprings of culture—that is, of some of the highest pleasures we can enjoy.

You will doubtless agree with this, and will agree, further, that without intellectual curiosity no amount of accumulated information can be properly assimilated, or will produce either culture or knowledge of permanent value. In its absence the pupil may pass through school and college with little advantage apart from discipline, beyond the acquisition of elementary skill in reading, writing, and arithmetic, and if he has a good memory a barren knowledge of some facts. You will probably add that it is one of the most important functions of the teacher to endeavour to produce this intellectual curiosity when absent or in abeyance, and that the zeal of the professional educator in this direction is a strong reason for enthusiastic belief in school education. It would be, I grant, if we could hope that the teacher's success would always be equal to his zeal; but notoriously this is far from being the case, and the failure is by no means always due to want of intelligence in the pupil any more than it is due to want of capacity in the teacher. In many cases, in all classes of society, the spark of intellectual curiosity—the response in the pupil's mind to educational stimulus—cannot be fanned into flame through book-learning alone, and yet may be there all the time ready to burst forth when it comes into contact with the needs of actual life and work. It may even be there, and fail to respond to imposed lessons, while it would blaze up if the pupil could by any means be induced to desire to learn before he is taught. It is partly because it is so important, if and when the desire to learn comes, that the boy or girl, man or woman, should be armed with the instruments which may give them independent means of acquiring the knowledge they desire, so far as this can be acquired through books, that we compel parents to send their children to school. No doubt, however, an even more important reason is our now almost universal use of reading and writing as a means of communicating with each other. The more widespread these arts are, the harder it is for anyone who has not acquired them to keep abreast of his fellows. But even now it would, of course, not be impossible, and the use of such phrases as compulsory education, in which education merely means the reverse of illiteracy, tends, I think, in itself to obscure the apprehension of what education really is, and to reduce the general sense of responsibility for it, and particularly that of parents.

Many years ago, before the days of compulsory education, or at least before it had time to produce any effect, I knew a man in the south of England who had had no school education, or practically none. I believe he could read a little with effort, but he could neither write nor keep accounts, so I was told. His wife did these things for him when they were necessary. He was, however, a good farmer, farmed a considerable amount of land, and acted as manager or agent under the landlord for a large estate. He knew his business thoroughly, had the power of managing men, and was much respected. It is impossible not to regard such a man as a more valuable member of the community, and a better-educated man in some respects, than many of those who climb the educational ladder to become clerks in an office. But, of course, such a man must have regretted that he had not had opportunities of schooling in his early youth—that he had not acquired the art of writing while he still had leisure. The want of the three R's must have been a serious handicap, only overcome by unusual ability. And, in fact, no one now doubts that it is almost as important to acquire these elementary arts as to learn to speak or walk. It is with the question of carrying school education further that doubt arises whether it is really the best education for everybody, and whether we ought to regard the person whose scholastic education has been longest, or who has succeeded best in examinations, as therefore necessarily the best educated.

I do not mean in saying this to set the practical man above the man of learning. Of course we want both, and we should like our schools to help to develop both. The value to the world of good scientific and literary work is enormous. And so far as science is concerned the British Association exists to bring home to the general public its value and interest, and consequently the importance of men who can advance it. Nor do I mean in what I have said to suggest any divorce between practice and learning. The business of most of us is practical, but what is to be desired is that everyone capable of it should combine practical ability—whether in manual work, or in organisation or administration, or in any other line—with a desire to learn; and that not only in relation to his work in life, but in a wider sphere. And, of course, we must wish that the means to satisfy this desire should be within everyone's reach. My point, therefore, is not that learning is not valuable, but that it is of little value unless it meets a desire in the learner's mind. And here the parents come in. The required attitude of mind is much more likely to be inspired by parents who possess it, than it is by the school. Or let us say that those children are most likely to grow up with it whose parents combine with the school to stimulate it. Unfortunately the result of compulsory primary education has not been to promote any sense of responsibility in parents as regards this; at least that is my belief. And I may, I think, appeal to Scottish experience in support of it.

The institution of parish schools is, as is well known, older in Scotland than in England. They date there from the Reformation, and were part of the ecclesiastical organisation initiated by John Knox. In the scheme drawn up by him and his colleagues education had a great place. The parish schools, in which Biblical instruction was foremost, were put in charge of the Church and long needed its efforts for their maintenance. Starting in this way the zeal for school education had become traditional. All respectable parents aimed at giving their children the best education they could. There was a strongly rooted sense of duty in the matter, and this from a double motive. They sent their children to school not only to help them to get on in the world, but because of the traditional association of knowledge and religion. Observe the educational value of this second motive. I am not looking at it from the religious point of view—that is not my business to-day. But as an instrument of culture the value of a desire for learning, based on something other than its relation to worldly success, is obviously great. It may be that the school education actually prevailing in Scotland is better now than that of fifty years ago, that the examination of the school inspector is more searching, if less stimulating, than was that of the Presbytery, that the average or backward child is less sacrificed to the clever one than used to be the case, and that general intelligence is more developed. But the parents, who felt their children's schooling to be their private concern, valued it more, took more personal interest in it, and felt more personal responsibility for their children's progress than parents can do now. And it is a serious question whether the

loss of this close link with home life has not had a bad educational effect, taking education in its wider sense, which is not compensated for by possible improvement in the schools.

I must admit that in saying this I have in mind only a limited area. I have made no wider investigation. The population I am thinking of is an entirely rural one in a purely agricultural district in the south of Scotland, with which I was intimately acquainted as a young woman, and which I re-visit from time to time. In such a district compulsion to send the children to school was unnecessary. It probably was required in the large towns and the more industrial parts of the country. I do not complain of the introduction of compulsion, but it did strike me at the time of its introduction that it was of very doubtful advantage in my own part of the country, and this impression has not diminished since.

To see if it was shared by others I wrote to a friend, more familiar with the district than I am now, to ask whether he did not think that parental interest in the children's school education had decreased, and also whether he thought that, as judged, for instance, by the books they borrowed from the parish library, the grown-up population was less inclined to serious reading than they used to be. I received from him a very interesting reply. He agreed with what I have just said as regards the first question, and after speaking of the warm and genuine wish in old times to give the children a good education, added :—

"The parents might, indeed, let their older children be absent for short times from school for light farm work or the like. But this was more than made up for by the zeal with which they were sent to winter evening classes, which could be gathered then far more easily than now. It is an unfortunate effect of legislation that it has largely deprived us of the great asset we had in the keenness of parental interest. It came about in this way. Government made it compulsory that no child should be employed in wage-earning who had not passed the fifth standard. Almost instantly the ideal of our people was lowered. A child was "educated" who had passed the fifth standard! And when by and by Government made it compulsory that a child should be at school till fourteen years of age, the parents in many cases felt this hard upon them, and our School Board every year has applications for permission to children to work before they are fourteen on various pretexts. I do not say that our people are not interested in their children's education. They still inherit that interest. But *compulsion*, and the fact of the responsibility being taken by Government, has greatly changed their attitude."

With regard to my second question—"Whether there is in country parishes as much reading of serious books, books of weight, history, travels, etc."—he says he "must answer *No.*" He thinks that the young people are perhaps more intelligent than they used to be, "but the reading is in enormous proportion novels and very light literature." He goes on to tell me of an old man who died two years ago "of the finest old Scottish type—devout, independent, interested in religious reading, in lives of men like Livingstone, in travels (he was reading Nansen in his ninetieth year and most interested in his nearing the Pole). But the list of books in his steady reading from the library here was of quite different character from that opposite other names in our catalogue of the same rank." He says also that forty or fifty years ago good audiences could be got for lectures—historical, travel, etc., but that now a good audience can only be got for concerts, entertainments, or at most lectures with lantern pictures. All this seems, so far as it goes, to show a diminution in culture, in capacity for the higher intellectual pleasures, in fruitful curiosity. My correspondent is not prepared, however, to say that this change is due to changes in school education. It comes, he thinks, "of the different spirit in young people, less under authority, indulging more in pleasures, not pressing hard or thinking they need this in order to get on." He thinks, in short, that the young men now are more self-indulgent and less energetic than they were, and he looks to the nobler spirit which the war has called out to carry us into better ideals of life. He may be right in thinking that causes independent of school education have produced the result. But we must admit that if it is true that, concurrently with a school education improved in some important ways, there has been a diminution in intellectual interests—in culture, in short—the school education has at any rate failed in one of the objects aimed at.

Well, you must take these views about a particular country district for what they are worth. Facts observed among a comparatively small number of people may not represent the average. Moreover, my correspondent and I are both old—we could not remember, or think we remembered, the state of things fifty years ago if we were not—and you may, if you think proper, discount what we have to say, on the almost proverbial ground that old people put the Golden Age behind them. I am not, however, myself conscious of any such tendency. I believe very much in progress, and look forward to a gradually improving world, and I believe we are on the whole improving in educational ideals and educational methods as in other things. But it behoves us to watch what we do, and not to acquiesce, if we can possibly help it, in loss on one side without being very sure that it is more than compensated for by gain on the other. The loss of the parents' real co-operation where it has existed, and the failure to gain it where it has previously been absent, is serious. It is serious even if it is limited to the intellectual side of education and does not extend to the formation of character, as I fear it sometimes does. With the greatest zeal the schoolmaster cannot replace the parents, nor even the parents' influence in producing the right attitude of mind in the pupil. And it is at the very least doubtful whether the better teaching which improved methods secure to the pupil can make up for any loss of spontaneous desire to put his own mind into the effort of learning for learning's sake.

And so I come back to the point that the general public must be encouraged to take its share even in the part of education carried on at school and college, and in particular those members of the general public who are parents of pupils. But this conclusion is rather barren, for I have no very definite plan to suggest for carrying it out. The State cannot now, even if it would, abandon the responsibility for the elementary school education of the children, and even if it could it is more than doubtful whether it would be desirable. For though we have now secured that all parents shall themselves have had school education, we still cannot trust them all voluntarily to give that advantage to their children. So the drawback must be put up with that parents cannot feel the same degree of responsibility resting on themselves when the responsibility is undertaken by the State.

It is to be hoped, however, that we shall be very careful how far we entrust to the State the regulation of education higher than the primary. Bureaucratic regulation may be well adapted to produce German *Kultur*, but it is not the way to secure the attitude of mind which leads to freedom, independence of thought, and culture in the best sense. And it is very apt to lead to want of independence in the teacher.

Probably our best hope for progress in the right direction lies in movements like the Workers' Educa-

tional Association, where we have voluntary effort put forward to satisfy spontaneous desire to learn. As this movement extends we may hope more and more to get a generation of parents who, having themselves experienced intellectual curiosity and the joy of satisfying it, who, having themselves felt the gain of a wider outlook on men and things, may by their example inspire their children with a similar disinterested desire for learning and culture.

NOTES.

THE members of the Siberian Expedition sent out from this country sixteen months ago, at the joint expense of the Oxford University School of Anthropology and the Philadelphia University Museum, reached London last week. The leader, Miss M. A. Czaplicka, possessed exceptional qualifications for the work entrusted to her, being a native of Russian Poland, and a distinguished student of the Warsaw University and of Somerville College, Oxford. The expedition consisted of Miss Curtis, the artist, Miss Haviland, ornithologist, and Mr. Hull, of Philadelphia University, ethnologist. They proceeded from Warsaw to Krasniack, in Siberia, and thence to the mouth of the Yenisei. The first tribe examined was that of the Samoyeds, and then the winter was spent among the Tungus of the Tundra, a very primitive race, little influenced by Russian culture. The spring was devoted to the Tartars, who are much more civilised than either the Samoyeds or the Tungus. Much information of scientific interest has been acquired, and a large collection of costumes, weapons, implements, and ornaments made of copper and iron has been made. These will, it is hoped, be exhibited in Europe and America after the close of the war.

THE Admiralty Air Department has been reorganised and for the future will be under the direction of a flag officer, with the title of Director of Air Services. Rear-Admiral C. L. Vaughan-Lee has been selected for this appointment. He held the post of assistant to the Director of Naval Ordnance from February, 1899, to July, 1900, and of Assistant Director of Naval Intelligence from January to December, 1905. The Director of the Air Department, Commodore M. F. Sueter, C.B., has been promoted to the rank of Commodore 1st Class, and will be in charge of the *matériel* side of naval aeronautical work, with the new title of Superintendent of Aircraft Construction. Commodore Sueter was appointed Inspecting Captain of Airships in September, 1910, and in 1912 he was selected for the post of Director of the Air Department.

AN exhibition of the various forms of apparatus found most useful in the treatment of fractures met with in the war will be held in the premises of the Royal Society of Medicine, 1 Wimpole Street, W., from October 7 to 11. During the exhibition Sir Almroth Wright will demonstrate his recent researches in the drainage of wounds.

WE learn from the *Kew Bulletin* that Mr. W. G. Craib, assistant for India in the Kew Herbarium, has been appointed assistant to the professor of botany in the University of Edinburgh, with the status of University lecturer on forest botany and Indian forest trees, Royal Botanic Garden, Edinburgh. Mr. J. Hutchinson succeeds Mr. Craib at the Royal Gardens, Kew.

THE death is reported, in his eighty-second year, of Dr. Carlos J. Finlay, who was associated with the discovery of the part played by the mosquito in the transmission of yellow fever and other diseases. He was a native of Cuba, and received his general education at the Lycée at Rouen, and his professional education at the Jefferson Medical College, Philadelphia. He then returned to Cuba and became one of the leading physicians in the island.

THE death is announced in *Engineering* for September 10 of Mr. G. W. Manuel, who for twenty-one years was superintending engineer to the Peninsular and Oriental Steam Navigation Company. Perhaps his strongest characteristic was his determination that the P. and O. mail liner should reach its port according to scheduled time without the variation of a minute, and no development was made unless he himself was perfectly satisfied that it could be relied on and would conduce to punctuality. Mr. Manuel became a member of the Institution of Naval Architects in 1879, and contributed frequently to debates. His death will be regretted by many sea-going engineers who have come under his influence.

WE regret to see the announcement of the death, on September 14, at eighty-five years of age, of Sir John Knox Laughton, distinguished particularly by his studies in naval history. Sir John Laughton entered the Navy in 1853 as a naval instructor, and was mathematical and naval instructor at the Royal Naval College, Portsmouth, from 1866 to 1873. He was then transferred in the same capacity to the Royal Naval College at Greenwich, becoming also lecturer on meteorology. In 1885 he retired from active service on being appointed professor of modern history at King's College, London, and from that date until his death he devoted himself almost entirely to studies of naval history. In addition to valuable works upon this subject, he was the author of volumes on "Physical Geography in its Relation to the Prevailing Winds and Currents," and "A Treatise on Nautical Surveying." From 1882 to 1884 he was president of the Royal Meteorological Society.

JULIUS PAYER, the discoverer of Franz-Josef Land, whose death on August 31 was announced in our last number, was born in Bohemia in 1841. He served with distinction in the war with Italy in 1866, before he joined the second German expedition to east Greenland in the *Germania*, under Koldewey, in 1869. There he acquired much experience in polar work, in the exploration of King William's Land and the extraordinary Franz-Josef Fjord. In 1871, through the liberality of Graf Wilczek, Payer and Weyprecht undertook an expedition in the *Isbjörn* to Spitsbergen and the Barents Sea as a preliminary to an Arctic expedition on a large scale. This expedition, the first to explore the north of the Barents Sea, was fruitful of discoveries there and in Spitsbergen and Hope

Island. The Austro-Hungarian Arctic Expedition sailed in 1872 in the *Tegetthof*. Weyprecht was again associated with Payer in the command. Their aim was to push north-east of Novaya Zemlya and return to Europe *viâ* the Behring Strait. From the first they met with misfortune. The *Tegetthof* was beset in the ice in 76° 22′ N., 63° E., and drifted with the pack throughout the winter in hourly danger of destruction. Twelve months later high land was sighted to the north-west and named Franz-Josef Land. A landing was made on one of the islands. A second winter was passed on the ice-bound ship, and in the summer of 1874 Payer conducted several sledge expeditions to explore the new land. Passing up Austria channel, he reached Cape Fligely in Rudolf Land in 81° 51′ N. North-eastward he saw further land, which he named King Oscar and Petermann Lands. In May the *Tegetthof* was abandoned, and after terrible hardships to get clear of the ice the expedition reached Novaya Zemlya in open boats in August, 1874. An English version of Payer's narrative, "New Lands within the Arctic Circle," appeared in 1876. In 1875 Payer was awarded the patrons' medal of the Royal Geographical Society.

In the course of excavations on the site of the great city of Pataliputra, the modern Patna in Behar, a discovery of much interest has been made. A vast pillared hall of the Maurya period, the third century B.C., has been unearthed. It contained eight rows of monolithic columns, fifteen feet apart, supporting a wooden superstructure which has been destroyed by fire. Some remarkable constructions of *sâl* wood beams have also been found, the object of which is uncertain; they may have been platforms for mooring boats, or supports for another portion of the building. The type of architecture at once recalls the great hall at Persepolis, and we have thus a further indication of the influence of Persian art on India during this period.

The great Buddhist Emperor, Asoka, was in the habit of inscribing his edicts on monolithic pillars or on rocks throughout his wide dominions. The Buddhist pilgrim, Hiuen Tsang, mentions specifically sixteen such pillars. Up to the present ten have been discovered, but only two of these can be identified with those mentioned by the traveller. The rock inscriptions, of which twelve have already been found, though not possessing the artistic interest of the pillars, are in some respects the most valuable monuments of his reign. The recent discovery of another rock inscription by some gold prospectors at a place not far from Raichur, in the Dominions of the Nizam of Hyderabad, is now announced. The Government epigraphist, Rao Sahib H. Krishna Sastri, is satisfied that it is a rock inscription. As the texts of these documents vary, the publication of the inscription will be awaited with interest.

Some admirable photographs of the adult and nestling of the Asiatic golden plover, and a most excellent account of the breeding habits of this bird, by Miss Maud Haviland, appear in the September issue of *British Birds*. The most important of her observations are such as concern the behaviour of apparently non-breeding birds of this species. On two points, however, she might well have been a little more explicit. The reader is left in doubt, for example, as to whether the newly-hatched nestlings accompany their parents, from the high to lower grounds, to participate in the formation of the flocks of which she speaks, and it would have been helpful to have had a more precise description of the plumage of the fledgling. Following Miss Haviland's paper comes a brief account, by Mr. C. W. Colthrup, of the idiosyncrasies of the nidification instinct in the redshank. Within the confines of the same marsh in Hampshire he found eggs in comparatively elaborate nests and screened from view by overarching stems of grass, while in other cases the eggs were laid in an apology for a nest, and without any attempt at concealment.

In the *Philippine Journal of Science*, vol. x., No. 1, Mr. R. P. Cowles contributes some extremely interesting notes on the habits of some tropical Crustacea. He deals more especially with the remarkable feeding habits of *Atya molluccensis*, and of several species of Caridina, and the peculiar structural modification of the chelæ associated therewith. In both genera the chelæ or "nippers" are armed with hairs, which, in Atya, can be opened to form funnel-shaped strainers for the capture of minute organisms, and closed to form a pencil-like brush, imprisoning the food thus captured, which is then conveyed to the mouth. While feeding, Atya, which is an inhabitant of running streams, remains perfectly still, with its strainers directed upstream. Caridina, with similarly armed chelæ, crawls about on the bottom of the stream, and uses the hairs, not as strainers, but as brushes, to sweep the bottom of the stream for minute particles of animal and vegetable matter. Mr. Cowles supplements these notes with valuable observations on the habits of *Myctris longicarpus*, which appears in countless numbers on sand-banks exposed at low tide. When the tide rises they immediately disappear beneath the sand. During their migrations they are continually smearing the sand over the mouth with the chelæ, apparently for the sake of the nourishment to be derived from the particles of animal matter it contains. These creatures are extremely difficult to approach, for on the slightest alarm they at once proceed to dig themselves into the sand, vanishing in about three seconds.

The recently issued part of Contributions from the United States National Herbarium, vol. xvii., part 6, is entirely occupied by an enumeration of the tropical North American species of Panicum by A. S. Hitchcock and Agnes Chase. One hundred and sixteen species and three subspecies are included, nine of which are new. The total number of species of Panicum in North America is now 216. Each species is accompanied by an outline map graphically representing its geographical distribution within the tropics of North America. There is also a key to the species and groups, and a complete list of the localities for each species is given.

A catalogue of the soft-water algæ collected in the Caucasus in the region of Czernomorsk is published

by M. A. I. Lobik in the Bulletin of the Imperial Botanic Garden of Peter the Great, vol. xv., No. 1, 1915. Sixty-five species are enumerated; they include one Floridean alga, *Batrachospermum moniliforme*, one brown alga, *Hydrurus foetidus*, twenty-five Chlorophyceæ, twenty-four diatoms, and fourteen members of the Cyanophyceæ. Among the Chlorophyceæ a new form of Spirogyra and of Cosmarium are described, and also a new genus, Leptobasis, among the Cyanophyceæ. This new alga, *L. caucasica*, forms the subject of a separate memoir by M. A. A. Elenkin, who, with M. V. P. Savicz, made the whole collection. Elenkin, in determining the new genus, revises the old genus Michrochæte, and considers that the genera Michrochæte, Coleospermum, and Leptobasis should be classed in different sections of the Hormogoneæ. The paper is illustrated with text figures.

In the *Philippine Journal of Science* for May (vol. x., No. 3), Mr. E. D. Merrills contributes four papers dealing with Philippine botany, and describes a number of new species of the genera Schefflera and Eugenia. In the opening paper on the present status of botanical exploration in the Philippines, which is illustrated by a map of the group, Mr. Merrill gives interesting particulars showing the amount of work which has been accomplished during the past thirteen years, and the parts of the archipelago which have been thoroughly explored. Compared with Java, Singapore, and Penang, the flora is not well known, and though much work has been done it has been confined to a few definite areas in Luzon and Mindanao. The islands are so densely forested that even in those regions visited by botanists on short excursions only a tithe of the plants has probably been collected, and a large number of endemic forms doubtless await discovery. Some fifteen years ago 2500 species of flowering plants were recorded from the islands; now the number is estimated at rather more than 7000, and it seems probable that 10,000 species is not an extravagant estimate for the phanerogamic flora of the Philippines. Some 40 per cent. of the whole Malay Archipelago flora will probably be found to be endemic in the islands.

Tare-like rogues appear from time to time among culinary peas, and are characterised by the possession of stipules and leaves narrower and more pointed than those of normal plants. The pods also are distinct, since they are always curved and narrow, even though the races in which the rogues have arisen bear straight pods, and the seeds are less sweet than those of the types. The seed-raiser has attempted to eliminate the rogues by destroying them as they appear, but all to no purpose; the rogue still reappears, and with the object of understanding its origin and finding a means of control, Mr. Bateson and Miss Pellew have conducted a series of investigations at Merton, and have published their results in the *Journal of Genetics* (vol. v., No. 1) for July. Though the research has been extended and a large series of plants examined, the origin of the rogue is still a mystery, nor has a method been devised as yet for the elimination of these tare-like plants. Rogues may depart widely or only slightly from the type; in the latter case rogue characters may only appear in the youngest parts, but as such plants can produce complete rogues among their offspring they should be weeded out. Rogues in breeding beget only rogues, and even in a strain of quite normal plants rogues occasionally appear. One remarkable result of the inquiry is that normal plants crossed with rogues always give rogues, and this was found to be true in fifty out of fifty-two crosses, and to persist through three generations.

The methods of bacterial analysis of air have recently been investigated by Mr. G. L. Ruehle in the course of an inquiry into the contamination of the air of cowsheds and its effects on the milk supply. In vol. iv., No. 2, of the *Journal of Agricultural Research*, a large number of comparative analyses is described in detail. Three forms of apparatus were used: (1) the standard sand-filter aeroscope of the American Public Health Association; (2) a modification of the standard designed by the author to permit sterilisation by dry heat; and (3) the Rettger liquid-filter aeroscope. The efficiency of the aeroscopes was tested by running two of each type in tandem so that the air passes through one filter and then through the other. The percentage of the total number of bacteria caught by the first filter determines the efficiency. The standard aeroscope was found to have a very variable efficiency, averaging 90 per cent., but the modified standard retained nearly 100 per cent. of the bacteria. The Rettger apparatus also gave excellent results, but required greater care in manipulation, as difficulties occur with foaming of the liquid during filtration and the tenacity with which the bacteria cling to the inner surface of the moist inlet tube. The method of determining bacterial precipitation from air by exposing Petri dishes is quite untrustworthy, as it only measures the number of bacteria-laden dust particles falling on the plate. The exposure of sterile water in pails gives an average bacterial count ten times higher than that obtained by the plate method.

We have received vol. xxvi. of the *Anales* of the National Museum of Natural History of Buenos Aires, containing a useful index to the first twenty volumes of this publication (1864–1911), and an interesting illustrated account of the fine new building for the museum which it is hoped will soon be provided by the Argentine Government. Under the energetic direction of Dr. Angel Gallardo, the technical scientific work of the museum has become very varied, and the newly-published volume contains several valuable contributions to systematic zoology and botany. There is also an exhaustive study of the collection of human skulls from Patagonia, with numerous tables of measurements. The most generally interesting research is a new examination of the deposits on the coast of the province of Buenos Aires containing human remains or implements made by man. This has been instigated by the criticisms of Argentine discoveries published by Drs. Hrdlička, Holmes, and Willis in their work on "Early Man in South America" (Smithsonian Institution, 1912). It is maintained that in the neighbourhood of Mar del Plata and Miramar there is no reason to doubt the association of evidence of man with late Tertiary

mammals, and a femur of a small Toxodont is described by Mr. Carlos Ameghino, showing a piece of worked quartzite which must have penetrated the bone during life.

THE Avezzano earthquake of January 13 last originated in a portion of Italy in which strong earthquakes are of infrequent occurrence. One of its latest predecessors, that of February 24, 1904, has been studied by Dr. A. Cavasino (*Boll. Soc. Sis. Ital.*, vol. xviii., 1914, pp. 411–48), and his conclusions are of interest in connection with the recent earthquake. The area of destruction contains only 54 square miles, and its centre lies about seven miles north-west of Avezzano. The two earthquakes were therefore in all probability associated with the same fault. As the disturbed area includes only about 4750 square miles, the focus cannot have been at a great depth. Using Dutton's method, Dr. Cavasino estimates that depth to be about 4½ miles.

A SUMMARY of the weather for the past summer is given in the issue of the Weekly Weather Report of the Meteorological Office. The period comprises the thirteen weeks from May 30 to August 28, and the aggregates of temperature, rainfall, and bright sunshine are given for the several districts of the United Kingdom. The mean temperature was below the average everywhere except in the north of Scotland, where the excess was less than 0·5°; the deficiency amounted to a degree in the south-east and south-west of England, and in the English Channel, whilst in other districts it was generally about 0·5°. The east of England was the only district with the absolute maximum temperature as high as 90°, and in all the western districts the thermometer failed to reach 80°. Rainy days were in fair agreement with the normal, whilst the total rainfall varied considerably in different parts of the United Kingdom. There was a deficiency of rain in the north and west of Scotland, the north of Ireland, the north-west and south-east of England, and in the English Channel; the greatest deficiency was in the west of Scotland, where the rainfall was only 72 per cent. of the average. There was an excess generally in the eastern district, in the south-west of England, and in the south of Ireland; the greatest excess was 123 per cent. of the average in the east of England. Bright sunshine differed very little from the normal, and the only districts with an excess were the north of Scotland and the north-west of England.

THE number of the Proceedings of the Tokyo Mathematico-Physical Society issued in June, 1915, contains a *résumé* in English by Mr. Tokurô Nakano of a magnetic survey of Japan for the epoch January 1, 1913, executed by the Japanese Hydrographic Office under the superintendence of Prof. Tanakadate. There were four survey parties in the field, and the whole of the observations were concluded within fourteen months, so that uncertainties arising from secular change were unusually small. A previous survey had been made for the epoch January 1, 1895, also under the supervision of Prof. Tanakadate, and the same instruments and a good many of the same stations were employed on the two occasions. A still earlier survey was executed in 1887 by Profs. C. G. Knott and Tanakadate. The 1913 survey, however, unlike the earlier ones, was not confined to Japan proper. Of its 331 stations, 78 were in Korea and 16 in Formosa; 38 of them were adjudged disturbed and left out of account in deducing the isogonals, isoclinals, and isodynamics. Formulæ were found for the values of the different magnetic elements, proceeding in powers of the latitude and longitude differences. Tables based thereon give the calculated values of the declination, dip, and horizontal force at the intersections of degrees of latitude and longitude. Similar formulæ were found for the secular change, and even for the rate of change, or "annual acceleration," of the secular change. The secular change conclusions were based on the results from fixed magnetic observatories and from stations common to two or more of the surveys.

THE Transactions of the Royal Society of South Africa, vol. iv., parts 1 and 3, 1915, contains three papers by Prof. J. C. Beattie dealing with terrestrial magnetism in South Africa. The first paper, read July 16, 1913, gives the values of declination, dip, and horizontal force observed by Prof. Beattie himself at about ninety stations in the years 1910 to 1913, and values of the declination observed by Mr. O. C. Macpherson at seven stations in 1909. Some of the ninety stations had been previously observed at by Profs. Beattie and Morrison during their survey of the epoch July 1, 1903. The new parts of the country dealt with included the West Transvaal, British Bechuanaland, and Bushmanland. The second paper, also read on July 16, 1913, gives a table of values of declination, dip, and horizontal force for the epoch July 1, 1908, at 255 South African stations. The observations had been made at various times from 1900 to 1913, the reductions to a common epoch depending on the secular change results obtained from repeat stations. There are three charts representing respectively the isogonals, the isoclinals, and the lines of equal horizontal force for the epoch considered. The third paper, read May 20, 1914, discusses the secular variation of the magnetic elements in South Africa between 1900 and 1913. There are three charts showing respectively the mean annual changes of declination, dip, and horizontal force. Westerly declination is falling throughout the whole of South Africa, the rate of fall being especially large—from 10′ to 13′ annually—along the east coast as far north as Mozambique. The southerly dip is increasing rapidly, but in this case the rate of change is largest—8′ per annum—in the neighbourhood of Cape Town. Horizontal force is diminishing rapidly, the annual fall in Cape Colony varying from 85γ to 100γ per annum. There are few parts of the world where so large secular changes have been observed, thus magnetic observations in South Africa are of exceptional value.

THE London Mathematical Society has issued, with the assistance of its official printer, Mr. T. T. Hodgson, a list of suggestions for notation and printing of mathematical formulæ, accompanied by a sample illustration showing the leads, spaces, and quadrats required in mathematical composition. Most of the suggestions might be summed up briefly in the

general statement that every symbol or sign introduced at a different level to the rest involves extra spacing, although this objection does not apply to the use of the ordinary indices and suffixes, or to the use of two lines to represent fractions in a line consisting entirely of formulæ. The use of a bar over a square root is objectionable, but we would suggest that the proposal always to use Roman or Greek *i* for the root of -1 is scarcely necessary, as the bar can be omitted in this case without ambiguity. The use of fractions in the middle of a line of letterpress produces an unsightly result. While agreeing with the suggestion that the small numerical fractions which are usually cast as single pieces of type can often be used with advantage, it should be noticed that "thirds" are not easy to distinguish from "eighths," and the solidus notation may often be used to overcome this difficulty. The avoidance of letters with bars or dots placed above them, to which much importance is attached, is a change which may often present difficulty, and it is doubtful how far the proposal to substitute dashes in the fluxional notation will be found practical in view of the frequent use of dashes for other purposes. There is, however, no reason why the raised dots should not be placed after instead of over the letters, while inverted commas offer another new opening, hitherto neglected. We should like to see "exp." included in the list of suggestions. But if writers of papers are sometimes to blame, printers have an awkward way of beginning a formula at the end of one line of letterpress and continuing it in the next line, even when the author has not done so. And we think the printers might at least take on themselves the responsibility of removing the bars over square roots. When, however, a paper refers to the rigid dynamics of aeroplane motions, the number of symbols required is so great that violation of every rule becomes inevitable.

In the second part of vol. iv. of the Science Reports of the University of Sendai, Prof. K. Honda describes a balance which allows the effect of temperature on any chemical change involving loss of material by evaporation or dissociation to be followed readily. The beam of the balance is a silica glass tube from one end of which a small platinum or magnesia vessel to contain the specimen is suspended, within an electrical heating coil enclosed in turn in a Dewar vacuum vessel. The other end of the beam is pulled down by a spiral spring, the pull of which can be adjusted to suit the specimen used. The movement of the beam is observed by means of a mirror attached to it and a telescope and scale, a deflection of a millimetre corresponding to about half a milligram. The temperature of the specimen is observed by means of a thermo junction, and is raised about a degree per minute. Curves showing the loss of water of crystallisation of two sulphates, the dissociation of a carbonate, and the change of chromic oxide with temperature are given.

"Red Book" No. 198 of the British Fire Prevention Committee contains the report of a fire test with three window openings filled with wired glass. These were subjected to the committee's standard 60-minute test at temperatures reaching up to 1600° F., followed by the application of water under pressure. The usual test size of glazed panels is about 2 ft. by 2 ft., but one of the panels under test in this case measured about 3 ft. by 2 ft. The classification of temporary protection (Class B) under the committee's standards has been accorded for this glazing to this larger size. Partial protection (Class A) has already been obtained for wired glazing by the same makers (Messrs. Pilkington Brothers, Ltd., St. Helens), both for regulation sizes and for a panel measuring about 4 ft. by 1 ft. In the present tests, in the case of two of the panels, neither fire nor water had passed through the glazing at the conclusion of the test, and the glazing remained in position after the application of water. In the third panel (two lights) fire had not passed through the glazing, but on the application of water the glazing in the lower light was perforated at the top portion, and some water came through. In this case also the glazing was in position after the application of water.

Mr. James Horsfall, late chief draughtsman of the Canadian Pacific Railway, suggests an improvement in the design of locomotive coupling and connecting rods. Such rods are subject to reversal of stresses due to the alternate push and pull, and also in the bending due to the action of centrifugal force. The effects of the latter may be reduced considerably by prolonging the rods beyond the pins and attaching balance weights to the extensions so formed. By suitably adjusting the proportions, the bending moment at the middle of the rod may be made zero, and the maximum bending moment on the rod will be much less than in the same rod unbalanced. Mr. Horsfall says that, as the result of very numerous experiments with rods of various kinds, he is convinced that the best way to avoid danger from the breakage of coupling and connecting rods is to counterbalance them in the manner suggested.

OUR ASTRONOMICAL COLUMN.

Comet 1915*d* (Mellish).—The discovery of a second comet during the present year by Mr. J. E. Mellish, Madison, Wis., U.S.A., was announced last Thursday in a telegram from Copenhagen. On September 6, at 22h. 9·1m., the comet's position was α 6h. 30·2m., δ 8° 50′ (approx. 8° south of γ Geminorum). No information was supplied regarding the direction or rate of the comet's motion, or of its magnitude.

Saturn.—Dr. Percival Lowell, in a letter to M. Flammarion (*L'Astronomie*, August, 1915), describes observations made at Flagstaff during last spring. Photographs were secured on March 12, when the ring system was practically at maximum apparent breadth. Cassini's division appeared continuous. With the planet thus framed in its rings a new determination of the aplatissement has been possible, giving the value 1/9·18

Radial Velocity, Magnitude, and Spectral Type.—Mr. C. D. Perrine has published (*Astrophysical Journal*, vol. xli., pp. 396–99) the results of further analysis of the data in Campbell's lists of radial velocities. Dividing the stars into two groups according to magnitude, drawing the line at 3.0m., he finds a decided increase of the mean radial velocity for the fainter group; this also holds for the stars of each

spectral type separately (except only the A stars), and the effect appears to be more marked in the later types. Further, the highest known velocities are found in the vicinity of the Milky Way. It is conjectured that the effect may be due to the operation of a resisting medium on stellar bodies differing in size and density, or the closer proximity of the fainter stars to a "source of general gravitational action." In either case the Milky Way would be deeply concerned.

In another note in the same journal Mr. Perrine analyses the spectral distribution of the stars of large radial velocity, finding the maximum mean values among the faint stars of classes F and G.

VOLCANIC DUST VEILS AND CLIMATIC VARIATIONS.—Fluctuations in the observed intensity of the solar radiation have been interpreted during the past ten years or so as traceable to the screening effects of the enormous quantities of dust poured into the upper atmosphere during notable volcanic eruptions; thus it has been a small step to the wider hypothesis that volcanic dust has been a possibly important factor in the production of past climatic changes. This hypothesis is tested by Mr. Henryk Arctowski in a paper communicated to the New York Academy of Sciences (Ann., Vol. xxvi., pp. 149–174, June, 1915). Previous work on temperature records had led him to the conclusion that a general rise in the temperature of the atmosphere was probably due to an increase in the solar constant itself. From a re-examination of temperature curves, chiefly showing departures from monthly means, paying special attention to the epochs of the Krakatoa (1883) and Katmai (1912) eruptions, as well as the year 1902, which was marked by intense vulcanism in both hemispheres, he now concludes that the short-period variations of temperature have nothing in common with the presence or absence of volcanic dust veils, although minor secondary modifications of the temperature curve may sometimes be traced to this cause. He finds that the sun-spot variation does appear to have an influence on atmospheric temperature, and, moreover, presumes, but does not explain, the existence of a correlation between the temperature changes and frequency of volcanic eruptions.

THE AURORA BOREALIS.—An illustrated account was given in NATURE, August 7, 1913, of the photographic observations made by Prof. Carl Stormer, in collaboration with M. Bernt I. Birkeland, in the spring of 1913. These observers were stationed at Bossekop and Store Korsnes respectively. They secured a great wealth of parallax material which will require a long time for reduction. However, one-sixth having been finished, Prof. Stormer has published a preliminary report ("Terres. Mag. and Atmos. Elec.," vol. xx., No. 1). Some six hundred measures of altitude have been worked out, most of the measured points lying between 90 and 130 km. above the earth's surface; none come out appreciably lower than 90 km., whilst the highest reaches 230 km. From a mere inspection of the diagram the mean height appears to be about 120 km.; thus the lower limit is fairly well marked. The spatial relations of a number of auroral curtains have been worked out in detail. In one case this information has been used in conjunction with magnetograms from the Haldde Observatory, to obtain an idea of the nature of the aurora. The curves show that the magnetic effect due to the passage of the particular auroral feature had components directed N.W. and upwards. On the assumption that the display was caused by electric corpuscles travelling towards the earth, Ampère's rule indicates that the observed deflections would result from the motion of particles carrying a positive charge.

AMERICAN HYDROIDS.[1]

MR. NUTTING may be congratulated on the completion of the third part of his great monograph on American Hydroids. He has a generous conception of America, and includes in his list such species as *Silicularia hemispherica* from S. Tierra del Fuego and *S. repens* from Kerguelen. It is therefore almost a monograph of the hydroids of the world, and will be regarded as the most important work of reference on the group that has yet been published. Those who are specially interested in Cœlenterata will probably be gratified to find that Mr. Nutting has taken a conservative attitude as regards species, and that, notwithstanding the many temptations to which he has been exposed in the course of his vast labour in this field, he has added very few new species to those already recognised. It is a much easier method—and a particularly attractive one in the preparation of a standard treatise on systematic zoology—to make new species when difficulties arise than to exercise the skill and patience that is required to place doubtful specimens in their proper specific groups, and we may regard it as a sign of Mr. Nutting's knowledge and thoroughness that the list of species is not a longer one.

The method adopted in dealing with the species is to select a specimen regarded by the author as typical, to give in a footnote the locality from which the speciment came, and then to describe it in detail. There is much to be said for this method in dealing with the systematics of Cœlenterata, because it gives the systematist a fixed point, as it were, around which the variants may be grouped, but it seems to us that to that description of a type some statement should be added of the principal variations observed by the author in the species under consideration in order that future workers in the group may find that some of the difficulties they are sure to meet with in using the monograph as a standard work of reference have been anticipated by a recognised authority.

The author has evidently taken infinite pains to collect from all available sources specimens of American hydroids for study and description, and his reference lists at the head of each species are extraordinarily complete and accurate. Our thanks are due to him for a very valuable work. S. J. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Board of Education informs us that the regulations and syllabuses which governed the examinations in science and technology held in 1915 will continue in force for 1916. In the prefatory note to the volume of regulations and syllabuses for examinations in science and technology, 1915, the Board announced its intention to discontinue those examinations at a date to be afterwards announced. The Board now gives notice that after 1916 it will no longer hold lower general examinations in any subjects of science and technology. The higher general examinations will for the present be continued.

THE prospectus for the forthcoming session of the Belfast Technical Institute has now been published. An interesting departure is the indication by an asterisk prefixed to the name of the members of the permanent staff who are at present serving in the Army or Navy, or who are engaged on war service. The number of asterisks is excellent testimony to the

[1] "American Hydroids." Part III. The Campanulariдæ and the Bonneviellidæ. Smithsonian Institution. Special Bulletin. Pp. 126+70 text figures+27 plates. Washington, 1915.

loyalty of the staff. The prospectus follows the general lines of previous years, and is, as usual, profusely illustrated. The Queen's University of Belfast and the Corporation of Belfast have entered into an agreement whereby the Technical Institute is recognised as a college in which students of the University may pursue a course, or part of a course, of study qualifying for a degree or a diploma of the University. The degrees obtainable are those of bachelor, master, and doctor of science. The departments recognised are those of mechanical and electrical engineering, chemical and textile technology, architecture and naval architecture. The day technical college has been established to provide instruction in the science and technology of mechanical and electrical engineering, the textile industries, and pure and applied chemistry, and gives a sound training for youths who aim at filling positions of responsibility in the various industries. Belfast may be congratulated upon the enterprise which has resulted in the establishment of an institution in which its young citizens can equip themselves fully for their parts in the industrial life of the community.

THE new session of the Battersea Polytechnic opens on September 21, and particulars of all the courses and classes are given in its calendar, which is now available. Full day and evening courses in preparation for the University of London intermediate and final degree examinations in science, engineering, and music have been arranged. In the day technical college, courses are arranged in mechanical, civil, electrical, and motor engineering, architecture and building, and chemical engineering. The training department of domestic science offers courses in preparation for the teachers' diploma in domestic subjects. The department of hygiene and physiology provides complete courses in training for women sanitary inspectors and health visitors. Full evening courses are provided in the various departments. In addition to its usual work, the polytechnic has adapted itself to meet the needs occasioned by the war, and the following will give some indication of what is being done:—Special Red Cross courses in first aid, home nursing, cookery, and laundrywork for women are being held. Belgian refugees are admitted to classes free of fee, and many such students have taken the motor-car engineering course, with a view to war service in France or Belgium. The mechanical engineering department is engaged in the manufacture of munitions, and the chemical department on the preparation of chemical substances for the Government. So far as is known at present 384 members of the polytechnic governors, staff, and students have joined the Forces, and at least forty-three of these hold commissions.

THE calendar for the next session, which is the hundred and twentieth, of the Royal Technical College, Glasgow, has reached us. It will be remembered that in 1913 the college was affiliated to the University of Glasgow. Candidates for the degree of B.Sc. in applied science may attend the necessary qualifying courses either in the University or in the college, or in both. A noteworthy testimony to the value of the instruction given at the college is its recognition by various professional bodies and Government departments. Thus, success in the civil engineering courses exempts from the examinations of the Institution of Civil Engineers; the college has been recognised by the Board of Trade as suitable for the training of marine engineers; the Home Secretary has approved the college course of study in mining engineering, and holders of the college diploma or B.Sc. degree in mining are entitled to the exemption authorised by the Coal Mines Act, 1911; the college is on the register of the Institute of Chemistry; and other instances could be given. The governors of the college have succeeded in securing the co-operation of employers. The calendar contains a long list of firms willing to allow a selected number of their apprentices facilities for carrying out a scheme of college study conjoined with practical work; and many Clyde shipping companies have promised to give special consideration to applications for employment from men who have gone through the college course in navigation. The work of great technical colleges like this institution is of vital national importance, and it may be hoped it will receive from the State the recognition it deserves.

THE acting registrar of the University of Durham has sent us a list of the members of the staff of the colleges of the university now serving with H.M. Forces to supplement the lists given in NATURE of July 15 and in other issues. The list includes fifty-five names, twenty of which are of members of the staff of the College of Medicine, Newcastle. We give the names only of members of the scientific staff on active service. *Durham Division*:—P. A. Brown, lecturer in economics, 2nd Lieut. 13th D.L.I.; F. C. H. Carpenter, lecturer in astronomy and observer, Lieut. 8th D.L.I. *Newcastle Division* (*Armstrong College*):—J. Gallon, prize demonstrator in mining, 2nd Lieut. R.F.A.; F. C. Garrett, lecturer in chemistry, Lt.-Col. N. Cyclists; A. A. Hall, assistant lecturer in agricultural chemistry, Lieut. 5th N.F.; H. M. Hallsworth, professor of economics, 2nd Lieut. O.T.C.; T. H. Havelock, professor of applied mathematics and mathematical physics, 2nd Lieut. O.T.C.; W. B. Little, instructor in horticulture, 2nd Lieut. 9th D.L.I.; H. Morris-Airey, lecturer in physics, Lieut. R.N.V.R.; J. Morrow, lecturer in engineering, Major, O.C., O.T.C.; A. D. Peacock, lecturer in zoology, Sergt. R.A.M.C.; J. H. Poulton, prize demonstrator in physics, Sergt. 9th N.F.; J. W. Ramsbottom, lecturer in commercial and industrial economics, Lieut. 20th Manchester Regt.; J. Small, demonstrator in botany, Corpl. R.A.M.C.; L. A. Thompson, lecturer in agricultural surveying, Lieut. 7th D.L.I.; L. M. Thompson, prize demonstrator in geology, 2nd Lieut. 11th N. Staffs.; T. Whitehead, assistant lecturer in agricultural and forest botany, Capt. O.T.C.; D. Woolacott, lecturer in geology, 2nd Lieut. O.T.C.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 6.—M. Camille Jordan in the chair.—A. **Lacroix**: A new type of alkaline granitic rock containing a eucolite. This rock was found at Ampasindava (Madagascar), and belongs to the eudialyte-eucolite group, containing zirconia (16·4 per cent.), and the oxides of cerium, lanthanum, and didymium (22·5 per cent.).—J. **Boussinesq**: The effect of a gradual contraction in a water main on the pressure in the contracted portion. A mathematical discussion of the Venturi effect.—Charles **Richet**: The stimulating action of magnesium salts on the lactic fermentation. The maximum effect on the lactic fermentation is produced by 12·5 grams per litre of crystallised magnesium chloride, $MgCl_2,6H_2O$, very near to the concentration of the same salt found by P. Delbet to exert the maximum effect on phagocytosis.—Paul **Vuillemin**: The morphological value of the corona of the Amaryllidaceæ.—Pierre **Delbet** and M. **Karajanopoulo**: Cytophylaxy. In the defence of the organism against infection the protection of the blood cells (cytophylaxy) is at least as important as the use of antiseptics, and the present paper gives an account of experimental studies of the action of the various solutions employed in the treatment of wounds on the

living cells of the blood, studies specially aimed at finding out any substance capable of increasing the phagocytic properties of the white corpuscles. Most of the antiseptics in current use reduce the phagocytic power; the best results were obtained with a solution of magnesium chloride containing 12·1 parts per 1000. This solution has a marked effect in increasing phagocytosis.—F. **Baldet**: The helicoidal filaments of the Morehouse comet (1908*c*). The electromagnetic interpretation of the forms of the filaments leads to attributing them to jets of electrons emanating from the nucleus and illuminating the gases of the tail of the comet during their passage.—M. **Auric**: A quadruple series of hexahomologic triangles.—Nicolas **Lipine**: The reduction of the periods of Abelian integrals and a generalisation of Abel's theorem.—B. **Galitzine**: An apparatus for the direct determination of accelerations.—Ed. **Delorme**: The ligature of the external iliac artery.—F. **Bordas** and S. **Bruère**: The action of the ferments of urea in the destruction of organic material.

NEW SOUTH WALES.

Linnean Society, July 28.—Mr. A. G. Hamilton, president, in the chair.—M. **Aurousseau**: Petrological notes. No. 1—Igneous rocks and tuff from the Carboniferous of New South Wales. Eleven rocks are described from three localities in the Hunter River Valley. The mode of origin of the rocks described is not yet settled. From internal evidence, they would appear to be volcanic. But Prof. David has recently met with an interesting section near Wallarobba, showing Martin's Creek andesite strongly intrusive, as a sill, into the Carboniferous sedimentary rocks; and he is of the opinion that sill-structure is more extensively developed in the Carboniferous rocks than has been supposed.—Dr. V. F. **Brotherus** and the Rev. W. W. **Watts**: The mosses of Lord Howe Island. Twenty-two species are described as new, as well as some new varieties, and many new records are given, some of which link up the flora of the island with that of the Northern Pacific. All the species recorded were collected by Mr. Watts in 1911.—G. I. **Playfair**: Fresh-water Algæ of the Lismore District; with an appendix on the algal fungi and Schizomycetes. This paper deals with the algæ and algal fungi collected, for the most part, from lagoons, swamps, rain-water pools, and roadside ditches almost entirely within the boundaries of the city of Lismore, during 1914. The fresh-water forms of the Richmond River, at Lismore, were treated of in a paper published last year. The total number of forms recorded from the river was 305; the corresponding number of the land-forms is 308 (of which 207 are additional to those recorded from the river). As the land-forms were collected over an area of about two miles in diameter, the grand total of 512 may be regarded as indicative of a rich microflora.—A. A. **Hamilton**: Topographical and ecological notes on the flora of the Blue Mountains. This paper deals with the range of the plants to be found on the Blue Mountains, in regard to elevation; and about 400 species are listed. The area selected is that between the Hawkesbury-Nepean and Eskbank, a region which includes the highest and lowest elevations on the mountains. It is shown that King's Tableland is a barrier, east and west, which checks or entirely prevents the ascent or descent of many species.

BOOKS RECEIVED.

Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1914. Pp. iv+84. (London: H.M.S.O.; E. Stanford, Ltd.) 1*s*.

Memoirs of the Geological Survey. England and Wales. Explanation of Sheets 330 and 331 (Mainland). The Geology of the Country near Lymington and Portsmouth. By H. J. O. White. Pp. v+78. (London: H.M.S.O.; E. Stanford, Ltd.) 1*s*. 6*d*.

The Royal Technical College, Glasgow. Calendar, Session 1915–16. Pp. 516+xxxviii. (Glasgow: Royal Technical College.) 1*s*.

The Municipal Technical Institute, Belfast. Prospectus, Session 1915–16. Pp. 388. (Belfast: Municipal Technical Institute.) 4*d*.

Ten Years' Work of a Mountain Observatory: A Brief Account of the Mount Wilson Solar Observatory of the Carnegie Institution of Washington. By G. E. Hale. Pp. 98. (Washington: Carnegie Institution.)

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. viii. Pp. v+256+plates. (Washington: Carnegie Institution.)

Acidity and Gas Interchange in Cacti. By Prof. H. M. Richards. (Washington: Carnegie Institution.)

Land Magnetic Observations, 1911–13, and Reports on Special Researches. By L. A. Bauer and J. A. Fleming. Pp. v+278+13 plates. (Washington: Carnegie Institution.)

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